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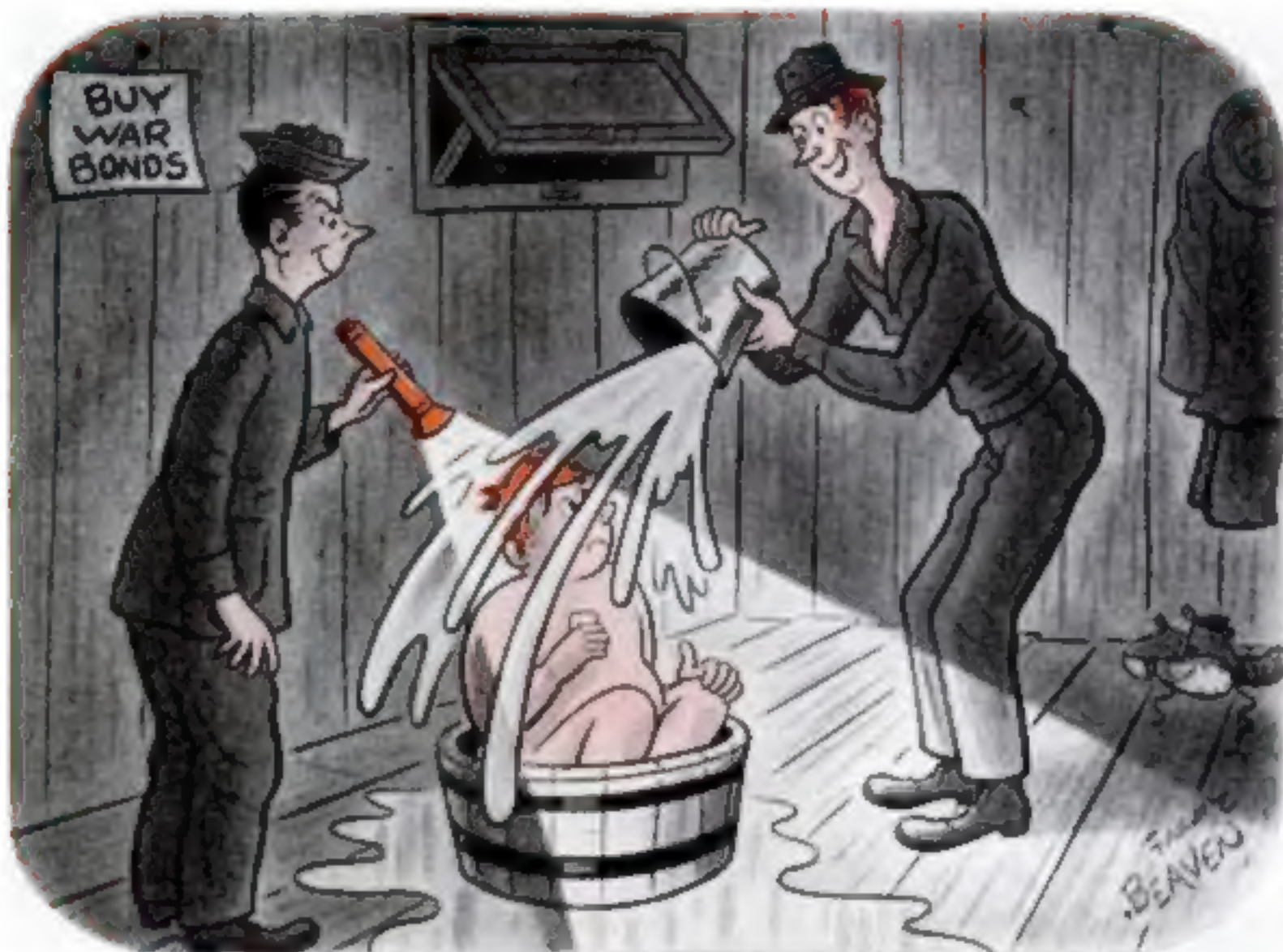
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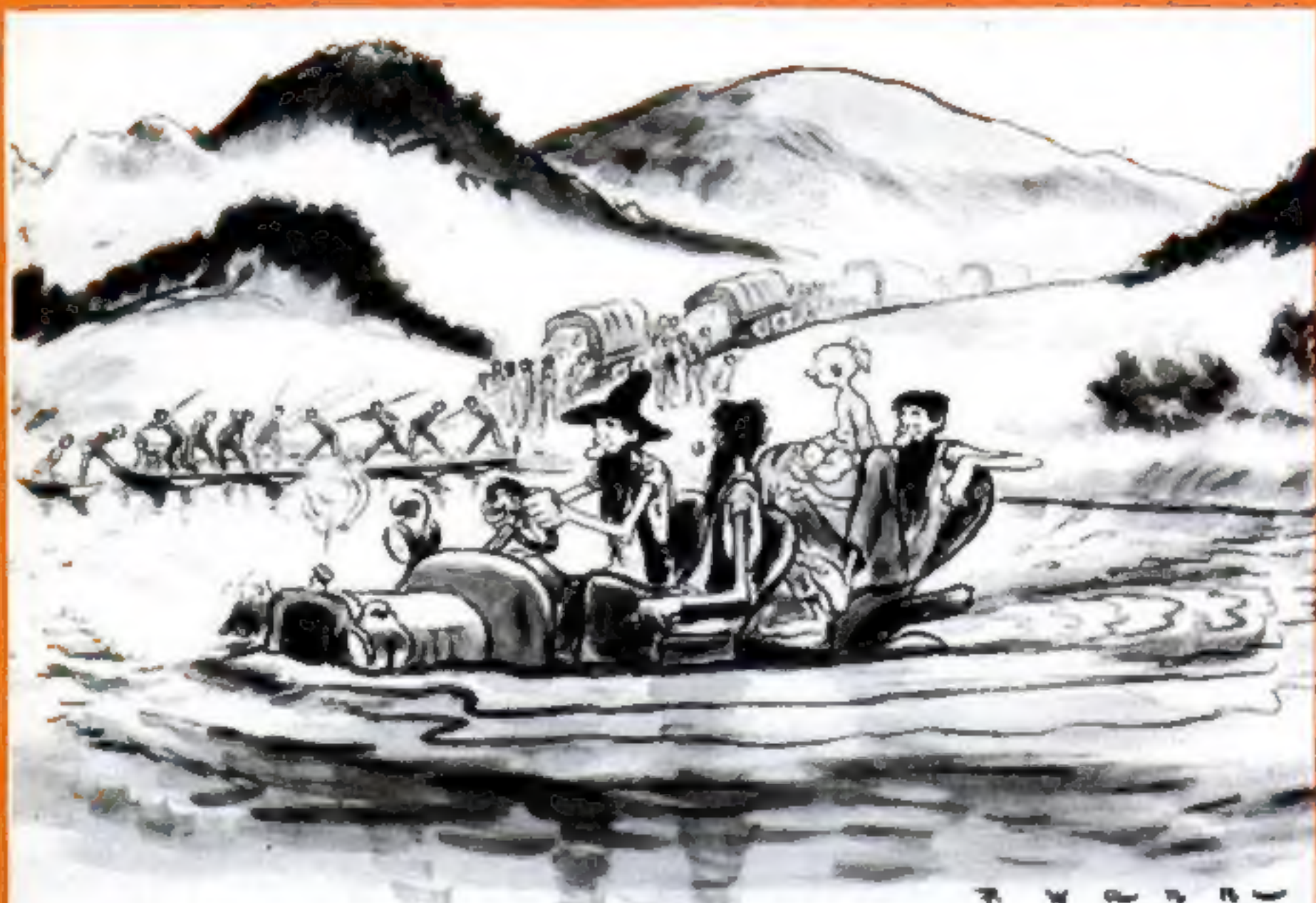
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CONTENTS for SEPTEMBER, 1944

Cover: Painting by Jo Kotula

News

ic Tugboat That Went Out to War....	59
Automatic Weapons Change Warfare..	64
Home Police for World Peace.....	72
ur AA Guns in One.....	80
w Tanks Score Hits on the Run.....	82
Hotter Steam Gives Navy Speed.....	86
Measuring the Rattler's Rattle.....	92
Odd-Job Planes Help Win Battles.....	94
How Science Made a Better Bee.....	98
Sidelights on the Soldier.....	104
Disney Puts People on the Screen.....	106
Guns That Think for Themselves.....	115
Come With Me on My Jeepmarine.....	123
The Plane You'd Like to Own.....	126
Electronics in Postwar Industry.....	128

Automobiles

Are You Wasting Gasoline?.....	142
Gus Referees an Election.....	146
Useful Auto Hints.....	149

Home and Workshop

How to Photograph Water.....	134
Furniture from Old House Trim.....	152
Scale-Model Hawker Typhoon.....	158
More Kitchen-Contest Winners.....	160
Back-Yard Roller Coaster.....	164
Oxy-Acetylene Cutting.....	174
Amphibious Alligator Tank Model.....	182
Mercury . . . the Liquid Metal.....	200
Keeping the Combine on the Job.....	203

(Contents continued on page 8)

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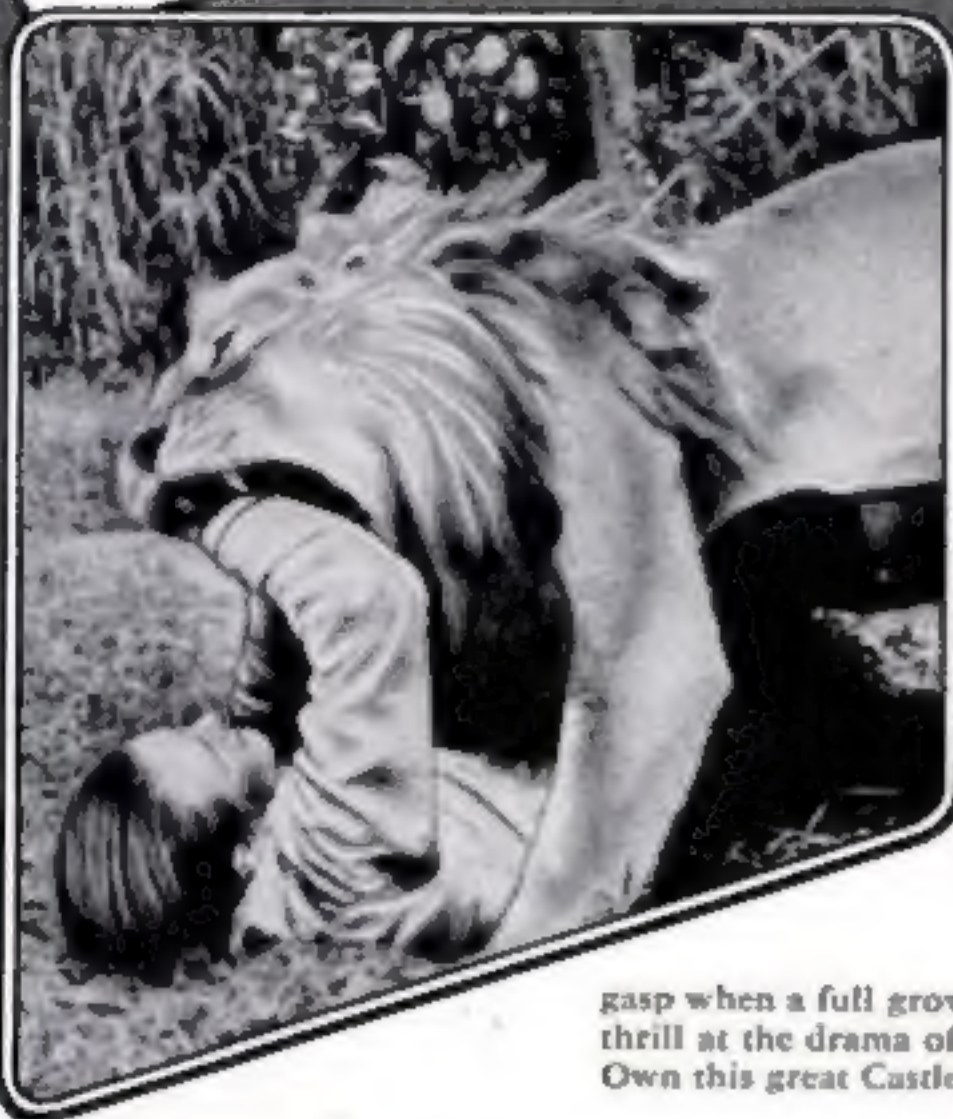
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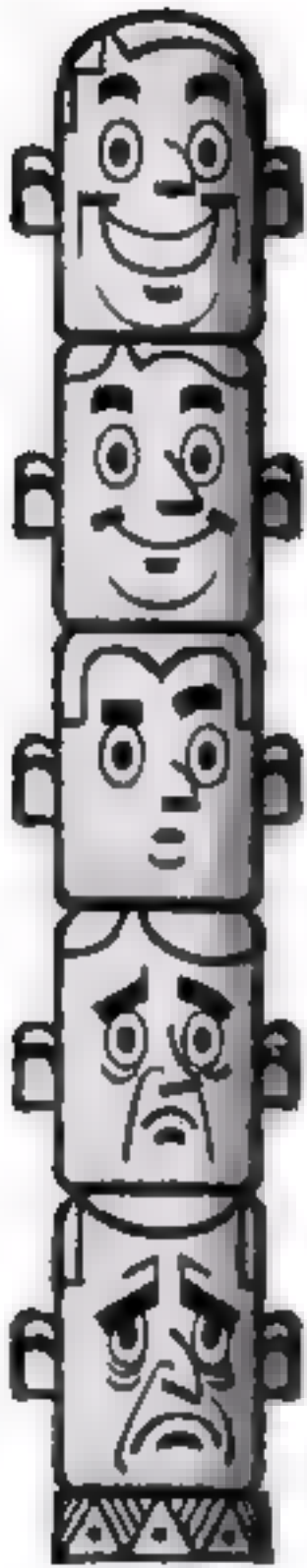
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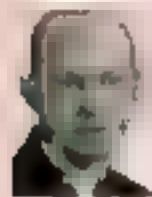
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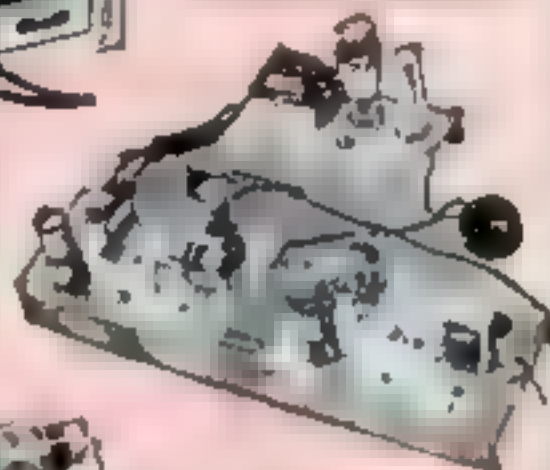
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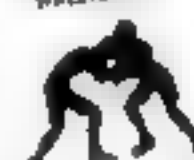
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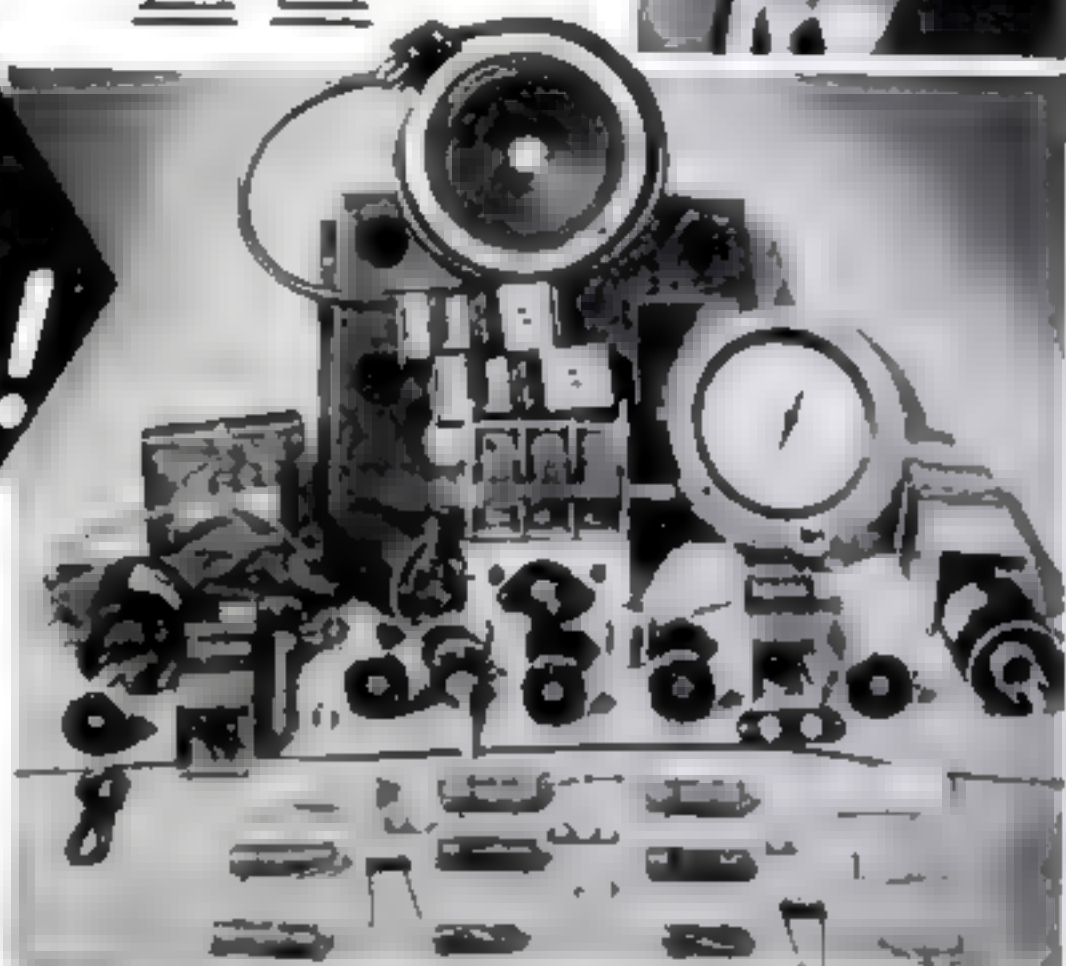
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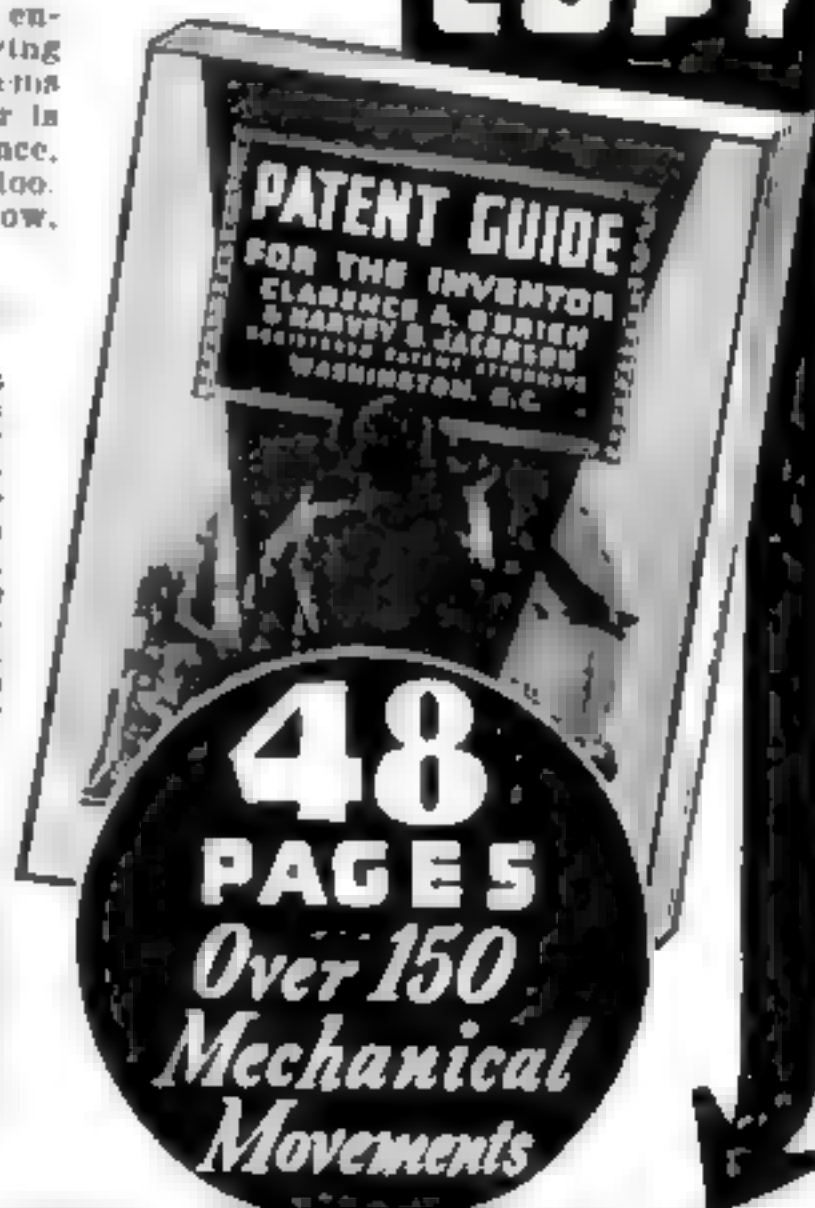
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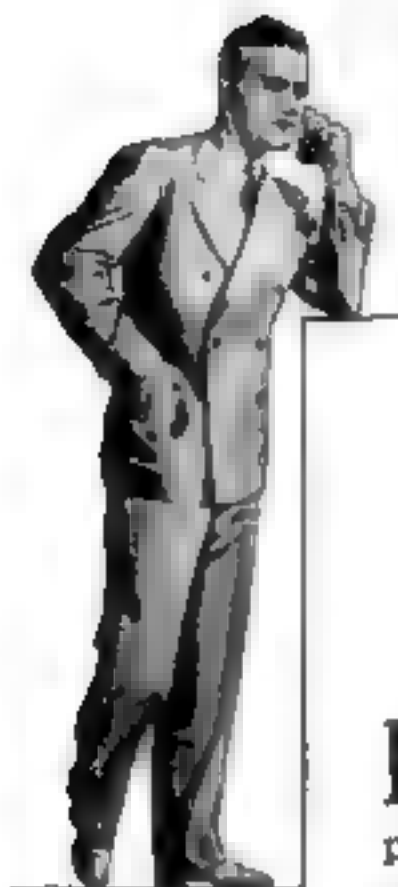
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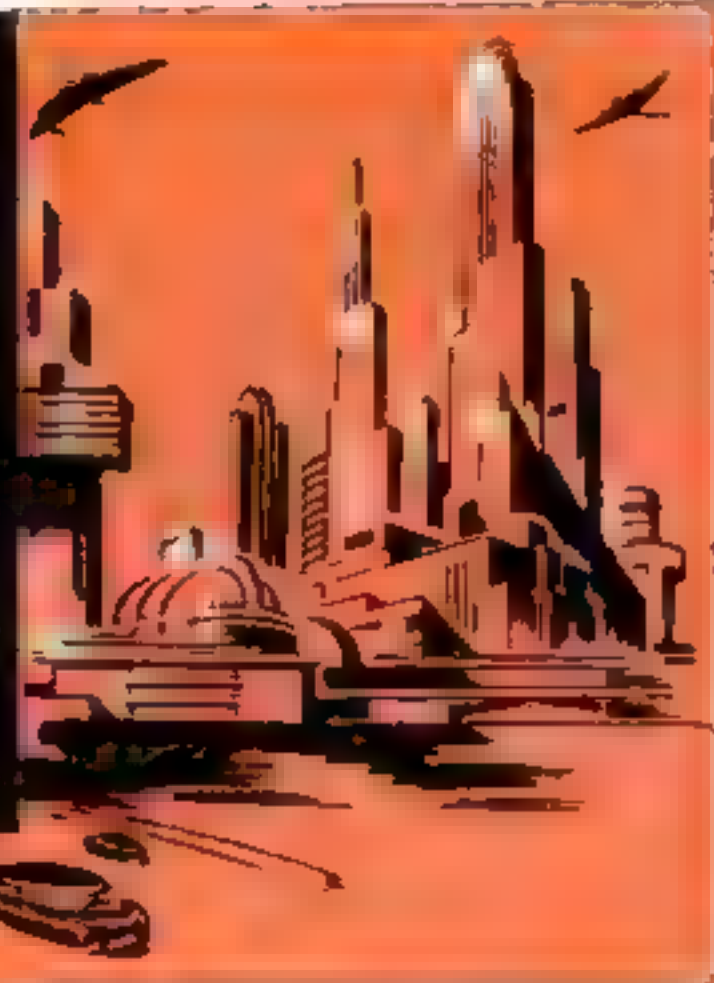
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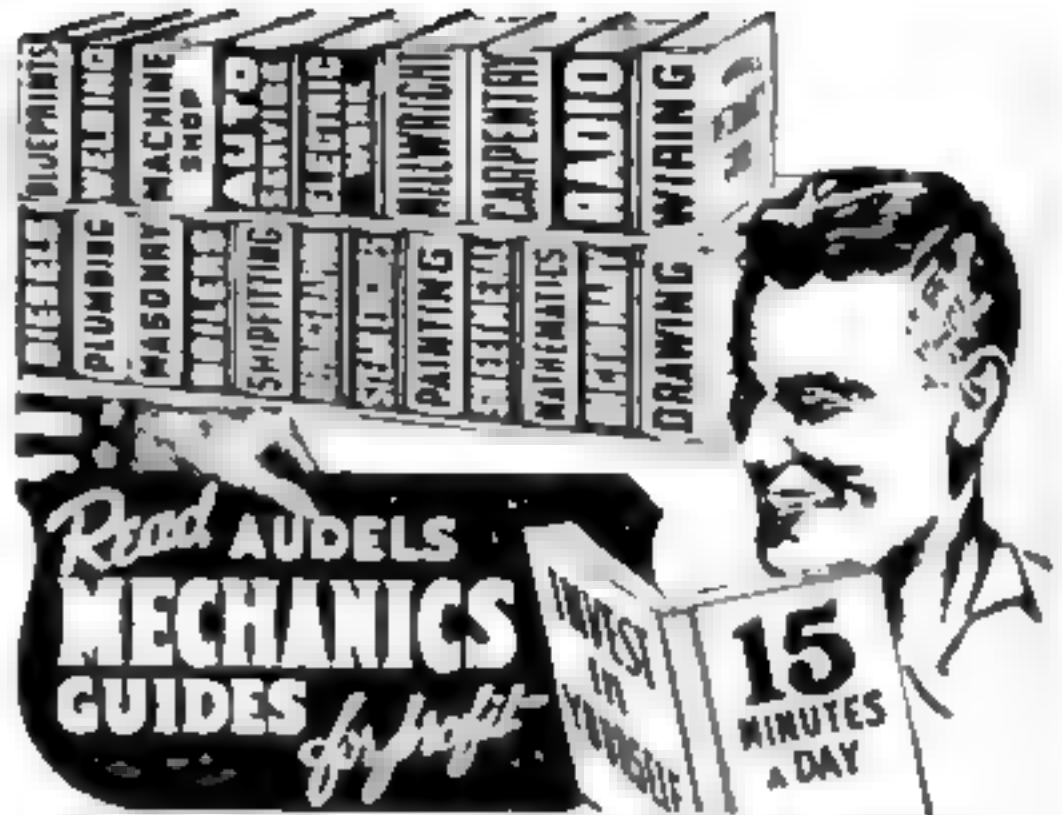
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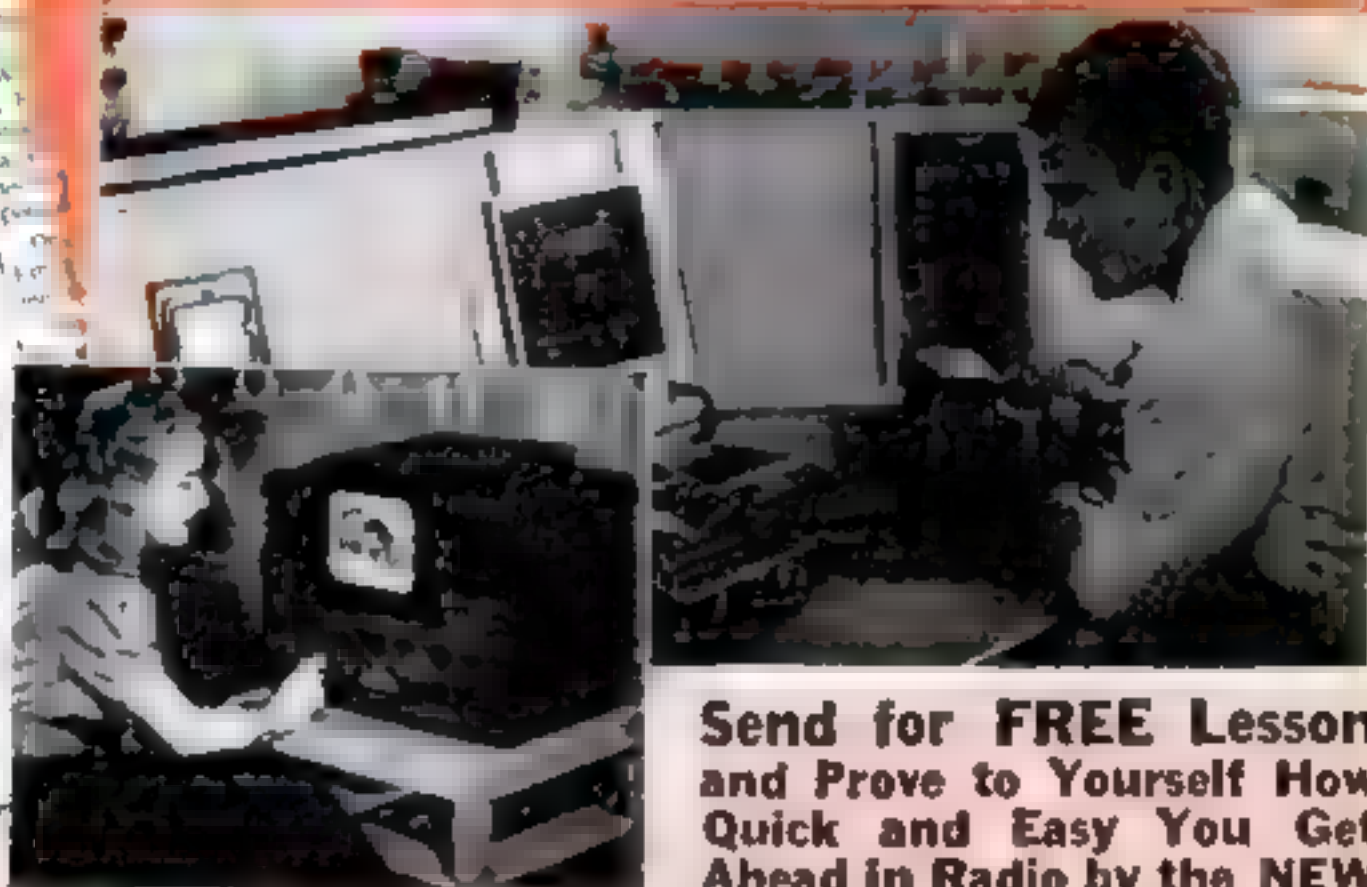
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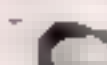
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1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

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N. A. 51

ACB

Abstract

ST 17E

Readers Say:

Bathtub Mystery Correctly Solved by 40 Readers

S.H.'s problem of the bathtub phenomenon has a very simple explanation. When someone is sitting in the tub, the water level is higher. Since Force equals Density times Height, the force sending the water out is greater. Incidentally, I certainly do enjoy reading my brother's copies of P.S.M., especially the Readers Say column.—Miss J. F., Washington, D. C.

Evidently the habit of scientific contemplation is practically universal among America's 150,000,000 bathers. There is first-class precedent for this sort of thing, for, as you will remember, it was while sitting in the bathtub that the Greek inventor Archimedes, about two centuries before Christ, hit upon the principle of specific gravity, shouted "Eureka!" and, with nothing on, rushed out to tell the world.—Ed.



This Man Would Beat LST's Into Plowshares

When the war is over, I would suggest that we strip the armament off the LST's and use them to set up trade routes among all the islands of the seven seas. Transportation and communication form the life line of civilization; lack of these is the basic cause of suspicion among tribes and nations. Make the trade routes free; make travel and communication easy; keep them that way and we shall have gone far toward abolishing wars. LST's don't need a wharf or expensive port facilities for loading and unloading. You just pump out the ballast, run up the beach at high tide, take on enough ballast to hold the ship in place, and then when the tide is out, unload and pick up another cargo. When the tide comes back, you proceed easily to some other spot. It would be a cheap means of inter-island communication.—R. F. M., Evansville, Ind.



Staff Artist's Preview of Miles 35 Rings the Bell

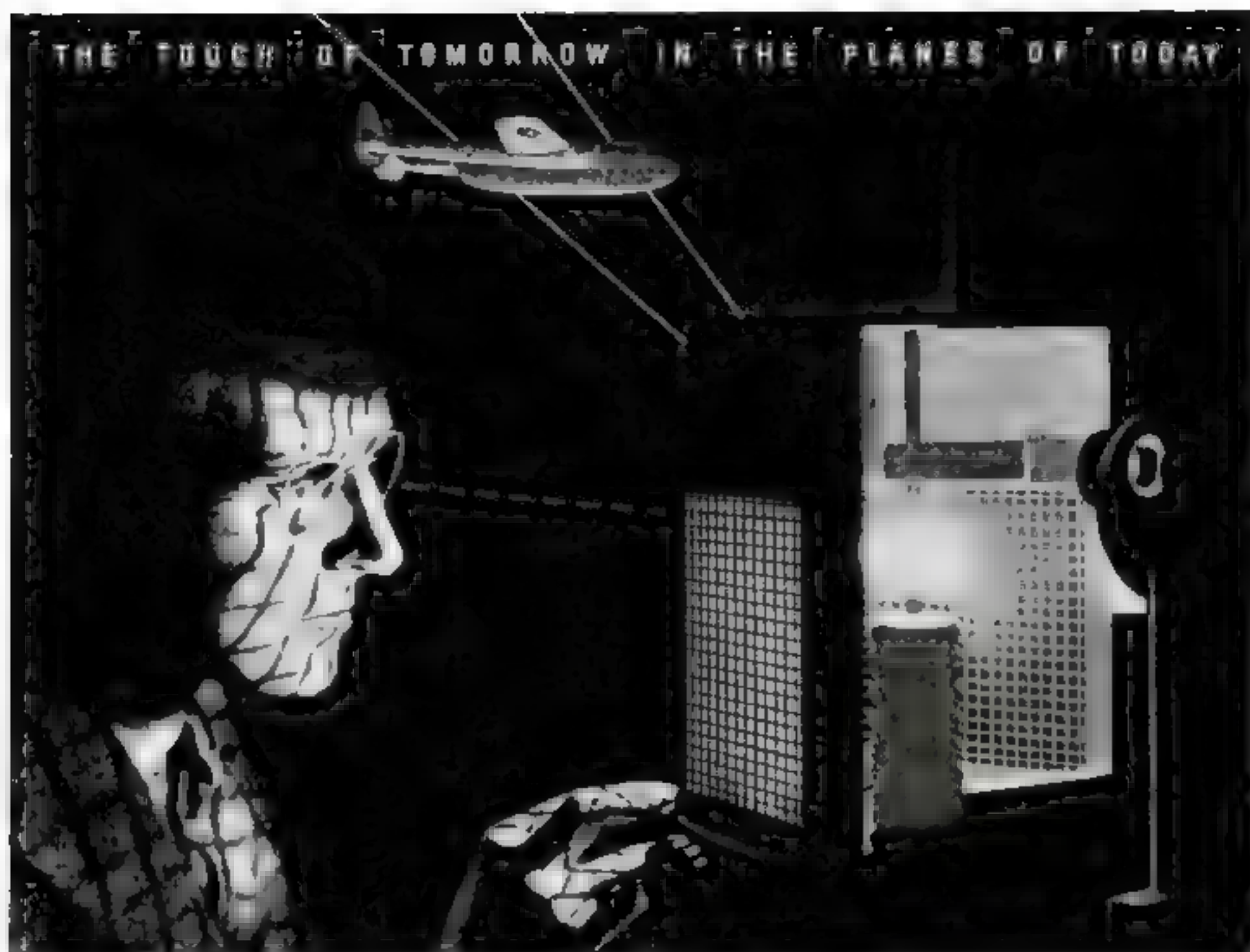
STEWART ROUSE's conception of the new British Miles 35 plane shown on page 93 of the August P.S.M. is remarkably like some actual photographs that I have seen since the magazine appeared. How does he do it? —L. T. McN., East Orange, N. J.

All that Rouse worked from was the information that came through far in advance of any photographs. Those who have followed his work in P.S.M. must know that his knowledge of aviation and other branches of mechanical progress matches his skill as an artist. And when he uses his imagination, the result is based on sound scientific principles.—Ed

Shoots War Idea Full of Holes

IN your article "War Ideas" on page 91 of the May 1944 issue of P.S.M., you have shown a bullet that defeats the purpose of the self-sealing aircraft fuel tank. However, as far as I can see, the device won't work for the simple reason that the bullet must first pass through the skin of the fuselage before it reaches the fuel tank. The loose-fitting jacket of the bullet would embed itself in the fuselage skin, and the bullet would pass on through to the fuel tank, which would then seal itself. In order for this device to work, the fuel tank of the airplane would have to be exposed. If this were the case, a double-walled tank would be the simple remedy.—W. W. L., Little Neck, N. Y.

W. W. L. is right. Items included under the heading of "War Ideas" are published for the purpose of stimulating the interest of the public in the scientific developments of the war and encouraging both amateur and professional inventors to use their ingenuity. Sometimes these ideas are not workable, as our correspondent reminds us, but more often they are, in which case they help to do a job on the Axis.—Ed.



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We Knew We'd Eventually Sell This Man a Bill of Goods

I HAVE been a faithful subscriber to your magazine for the last 17 years. In all this time I have used P. S. M. as an escape from the ordinary routine of life. I own no tools, cameras, laboratories, or equipment for pursuing the various hobbies that your magazine so ably explains. The publication has served one purpose, that of supplying material for dreams of my leisure. Now I have found ground for complaint. On page 117 of your August edition, you clearly showed the correct method for exterminating flies with the common

swatter. It works, as I have found to my delight. I guess I will have to abandon my desultory reading and go to work. I am writing to complain that you have shattered my complacent regard for your magazine. From now on I must consider it a trap for the unwary, set to ensnare him in the ways of industry. (P. S. Thanks for the tip).—T. R. J., Jr., Buffalo, N. Y.

Well, now everybody but the flies likes P. S. M.—Ed.

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EITHER
OF US!**



Does an Ascending Ball Stop Before It Comes Down?

A LITTLE problem that has caused quite a bit of discussion at camp seems to me would be a good one for Readers Say. A ball is tossed straight up and comes back down, landing on the same spot it started from. Now the question is: did or not the ball stop when it reached the top of the toss? The general feeling seems to be that it had to stop in order to reverse directions. This brings up the question of the definition of stop and most everyone will agree that he thinks of it as remaining motionless for some length of time. In order to fit this definition, the ball couldn't have stopped at all as its change of velocity due to gravity, disregarding air resistance, is constant for any span of time, no matter how short.—Pvt. J. M. K., Camp Santa Anita, Calif.



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Needles and nails made his first watch tools . . .

THE March wind rattled the bedroom window. But the lantern on the floor gave a steady glow to warm the boy's feet.

Then his head bent more closely to the work. He nudged the balance wheel—and life came back into the timepiece.

Watch repairing was coming easier to young Henry Ford. He had started at 14 and the first watch (today in his collection at Dearborn) had been mended with a shingle nail, a corset stay, and knitting needles. Now, after school, he was neighborhood watch repairer.

Everyone was enthusiastic

about his work, particularly because he didn't charge for it. But it wasn't money that Henry Ford was interested in. Here was an opportunity to *learn by doing!*

Years later, the watchmaker's precision learned by Henry Ford in those winter nights was to guide the building of 30 million cars and trucks. Moreover, it was Mr. Ford's knowledge of watchmaking that prompted inauguration of the assembly line. This in turn brought shorter working hours, increased wages, made life easier for millions, and is now speeding equipment to preserve our American way of living.

New cars belong to the future. But when tomorrow's Ford, Mercury and Lincoln cars arrive, they will reflect anew the watchmaker's skill, the workmanship and engineering resourcefulness that are typical of Ford Motor Company.

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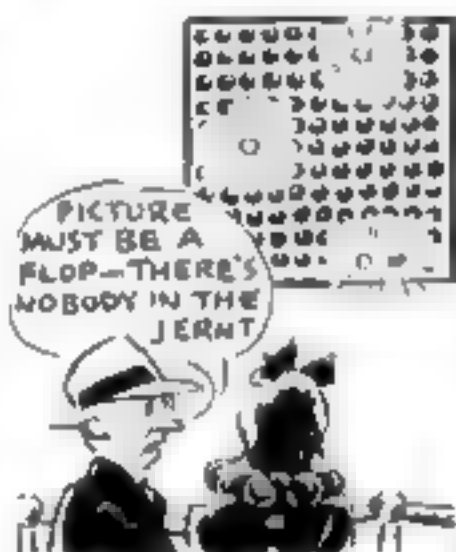
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Readers Say:

And a Short Circuit Might Provide Additional Thrills

IN A recent issue I saw an article on glowing seats in a theater. I have an idea that would also guide moviegoers to their seats and would eliminate ushers. The idea is to have a pushbutton put on every seat in the theater and connect it to a large board in the back of the house. On the board have small electric-light bulbs connected to the electric circuit. Have the bulbs fixed so they would either go on or off when a person sits down in the seat. Have the bulbs arranged in rows on the board, and have a bulb for every seat. Have the numbers of the rows marked in luminous paint on the floor by the aisle.—B. G., Columbus, Ohio.

New York's Roxy Theater for several years used an arrangement similar to the one B. G. suggests. A board showed a light for each unoccupied seat in the balcony. When the spectator sat down, the light went out. The system is not now in use.—Ed.



Tame Rose Hips Are As Efficacious As Wild

Your article on wild rose hips used as vitamin C for ascorbic food content is not new. In Russia they have been used in sirup, marmalades, candies, and a very refreshing drink. You can use the seed pods from any garden rose hips as well as those from wild roses. I have misplaced my statistics on the matter, but I believe one teaspoonful of the strained cooked mass has as much vitamin content as one orange. I tried it last year myself.—L. L., Brooklyn, N. Y.

Our correspondent has overlooked the news feature of this item in the July P.S.M.: the wartime use of a source of vitamin C that may be available where such valuable sources as oranges, lemons, canned tomatoes, and raw cabbage are lacking. Vitamin C also occurs in a number of other fruits and vegetables in varying amounts. Among these are raw apples, raw or sprouted beans, carrots, and peaches.—Ed.

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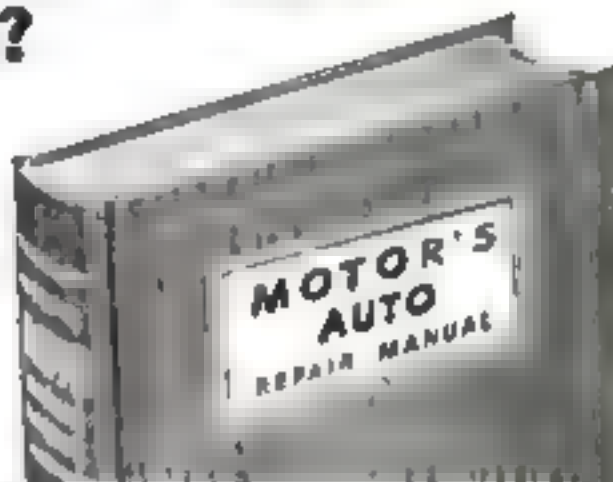
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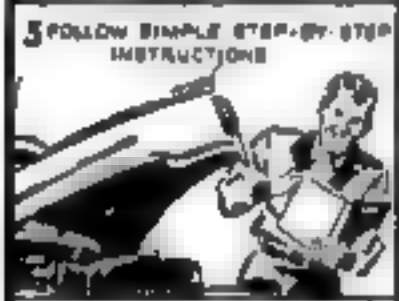
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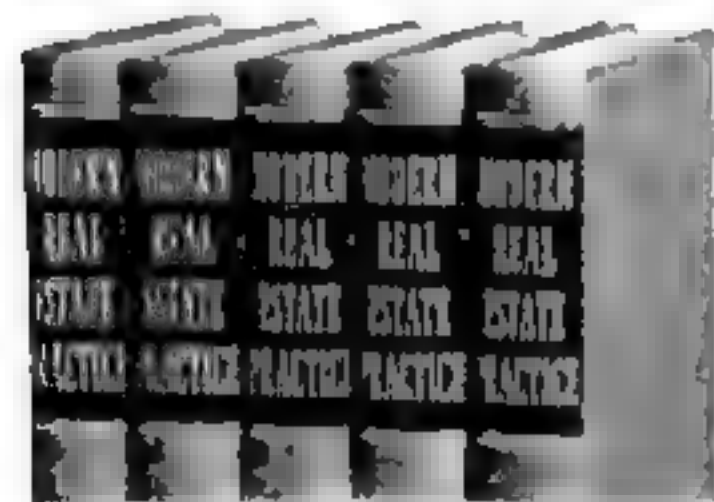
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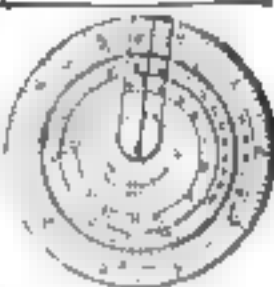


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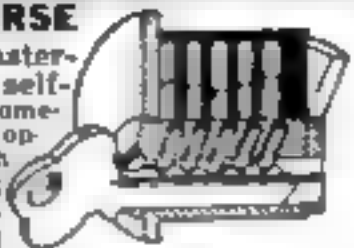
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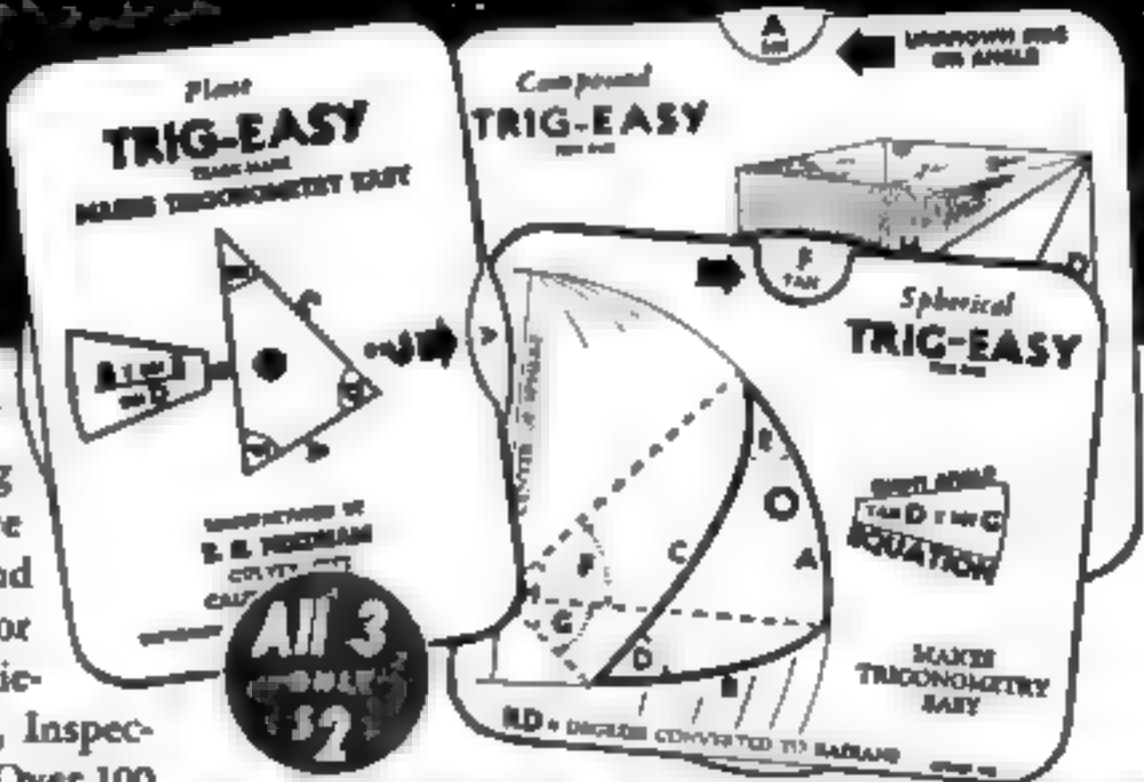
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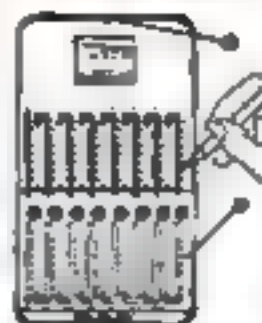
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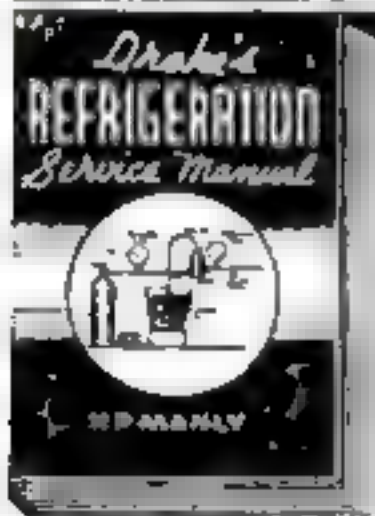
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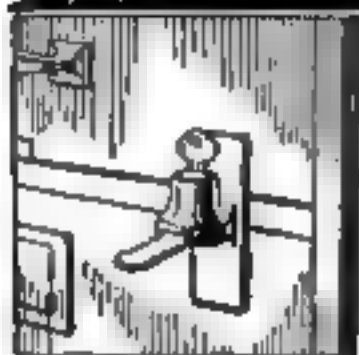
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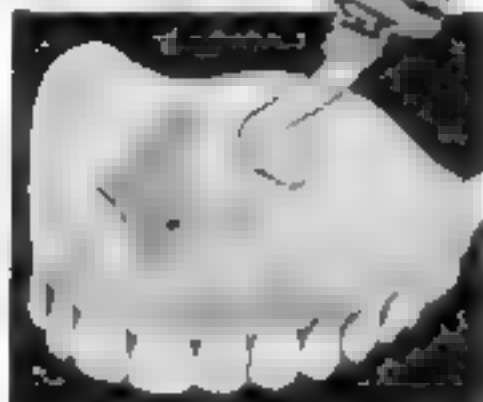
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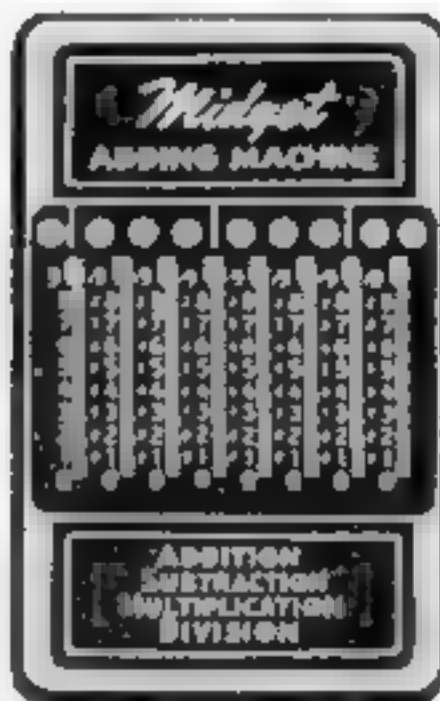
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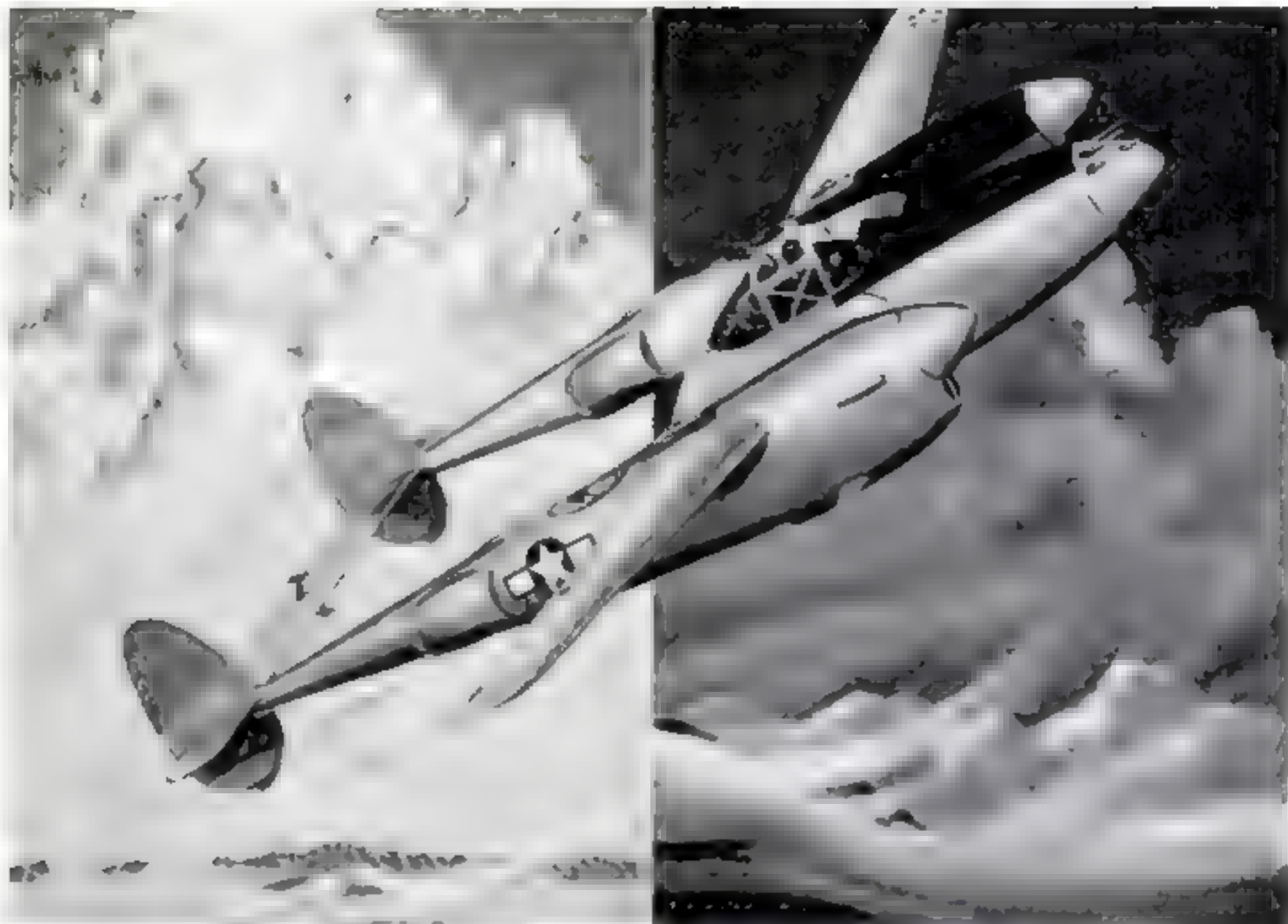
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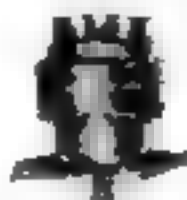
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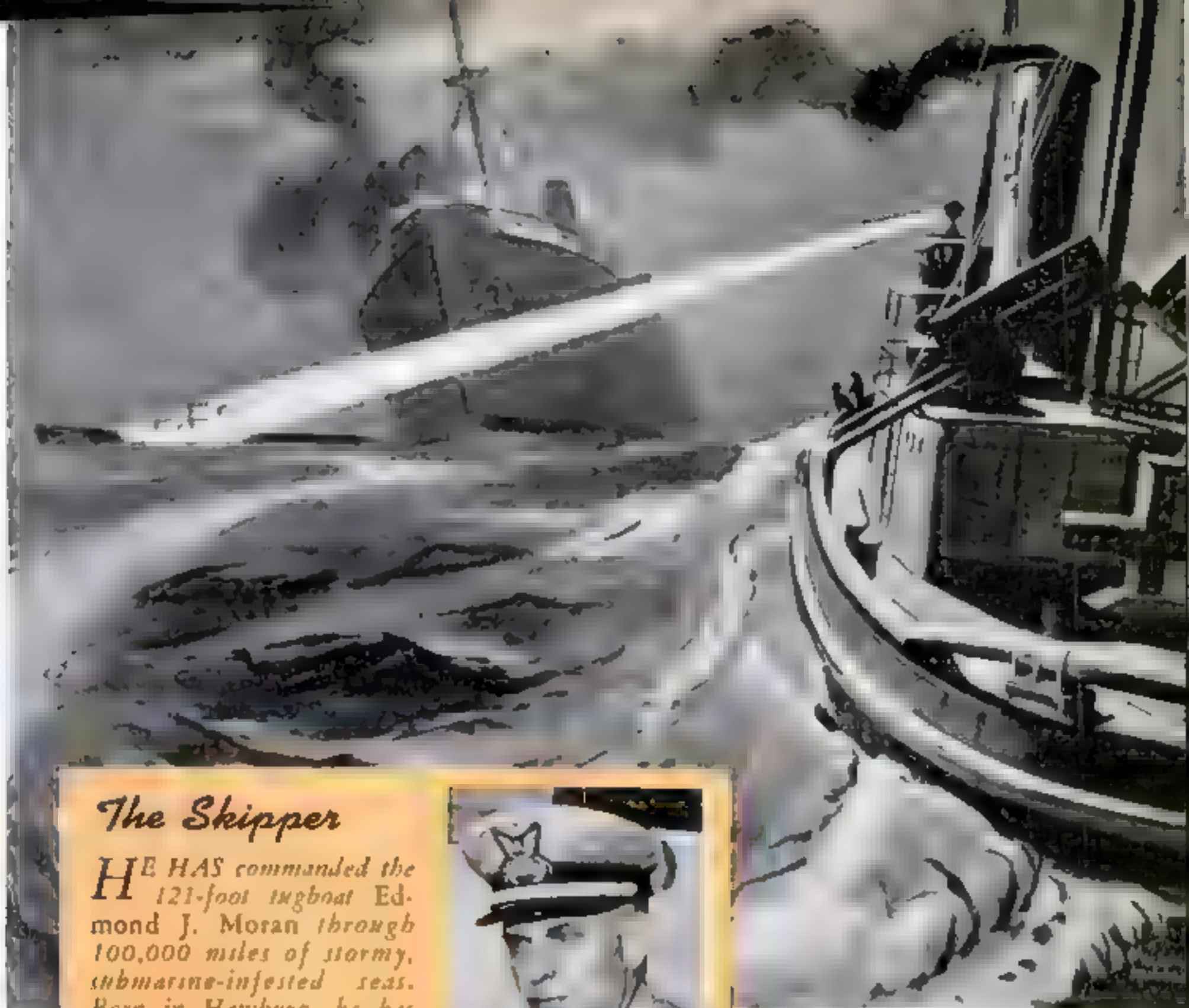


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The Skipper

HE HAS commanded the 121-foot tugboat Edmond J. Moran through 100,000 miles of stormy, submarine-infested seas. Born in Hamburg, he has been an American citizen for 28 years. During the war, he has been saving men and ships from Germans, Japs, and Davy Jones.



CAPT. HUGO KROLL

Slipping the hawser from the torpedoed ship, the tug slanted a flash of the attacker, blocked out, and then dodged the sub until dawn, when the one last member of the crew was saved.

The Tugboat That Went Out to War

From Greenland to Alaska, this seagoing powerhouse has played tag with U-boats and braved the deep-sea storms to help out our fighters. Read the tale of her adventures, which even a destroyer might envy.

FOR 30 years, Capt. Hugo Kroll chugged around New York harbor, towing garbage barges and shoving liners in and out of slips. But for three years now, the Big Lady with a Lamp who symbolizes liberty has seldom heard his whistle. For the captain and his super-towboat have been roaming two great oceans, saving men and ships from Germans, Japs, and Davy Jones.

Captain Kroll is a stocky, weatherbeaten little mariner, born in Hamburg but an American citizen since 1916. On his fiftieth birthday, September 11, 1940, his bosses assigned him to their brand-new, 121-foot, 336-ton towboat *Edmond J. Moran*. With

ADVENTURES OF

that half-million-dollar Texas-built floating powerhouse he has plowed, raced, sneaked, and strutted for 100,000 miles—four times the distance around the world—despite submarines, mines, and savage storms. He has made the *Moran* the tugboat heroine of this war, and he would rather remain at her wheel than be a Commander in the U. S. Navy.

"I wouldn't want you to hear what I call her sometimes," he admits; "but she knows what I mean, that old girl. She knows what she's got to do when I tell her."

Other tugs have fulfilled such wartime missions as towing strings of barges clear across the perilous Pacific, but no tug has lunged through any more stirring adventures than the mighty *Moran*. She has ridden the very crest of this bloody tide in men's affairs ever since she left for Greenland, three months before Pearl Harbor, with a big, clumsy dredge in tow. She pulled that mammoth machine 4,014 miles, through a southern hurricane and arctic gales, in less than 30 days to strengthen the air-and-sea life line between John Bull and Uncle Sam. And by the time Congress declared war, she was back in the blue Caribbean, thwarting U-boats.

"Give us our orders," her captain radioed then. "We will tow anything that can hang onto our line, and take it anywhere."

So his log was soon well strewn with such terse entries as "9:10 p.m., received message of storm warning and submarine in near-by waters" and "3:50 to 6:50 a.m., ran away from U-boat." Once when a submarine surfaced like a whale close to starboard, the tugboat came within inches of ramming and slicing the Nazi marauder open before U. S. Navy gunners disposed of it. And once when Captain Kroll, with an Army transport in tow, proceeded to investigate what looked like a periscope, he found it was the makeshift mast of a lifeboat containing eight torpedoed British seamen, who were mighty glad that the *Moran* had not taken to her heels.

But that's only the beginning of the long, true story of this civilian skipper and his beloved tugboat.

Coming up the Gulf Stream off Florida one night with a British passenger-and-cargo ship in tow, Captain Kroll felt the hawser with his hands as usual, to test it for unusual strains. Although his boat was well supplied with control instruments, he did not always trust them, and went partly by the feel of things. There were 90 men and a woman aboard the disabled liner at the far end of his line that starlit night.

The British ship had been torpedoed twice, and the *Moran* was hauling her to Baltimore to be repaired. But towing a crippled ship



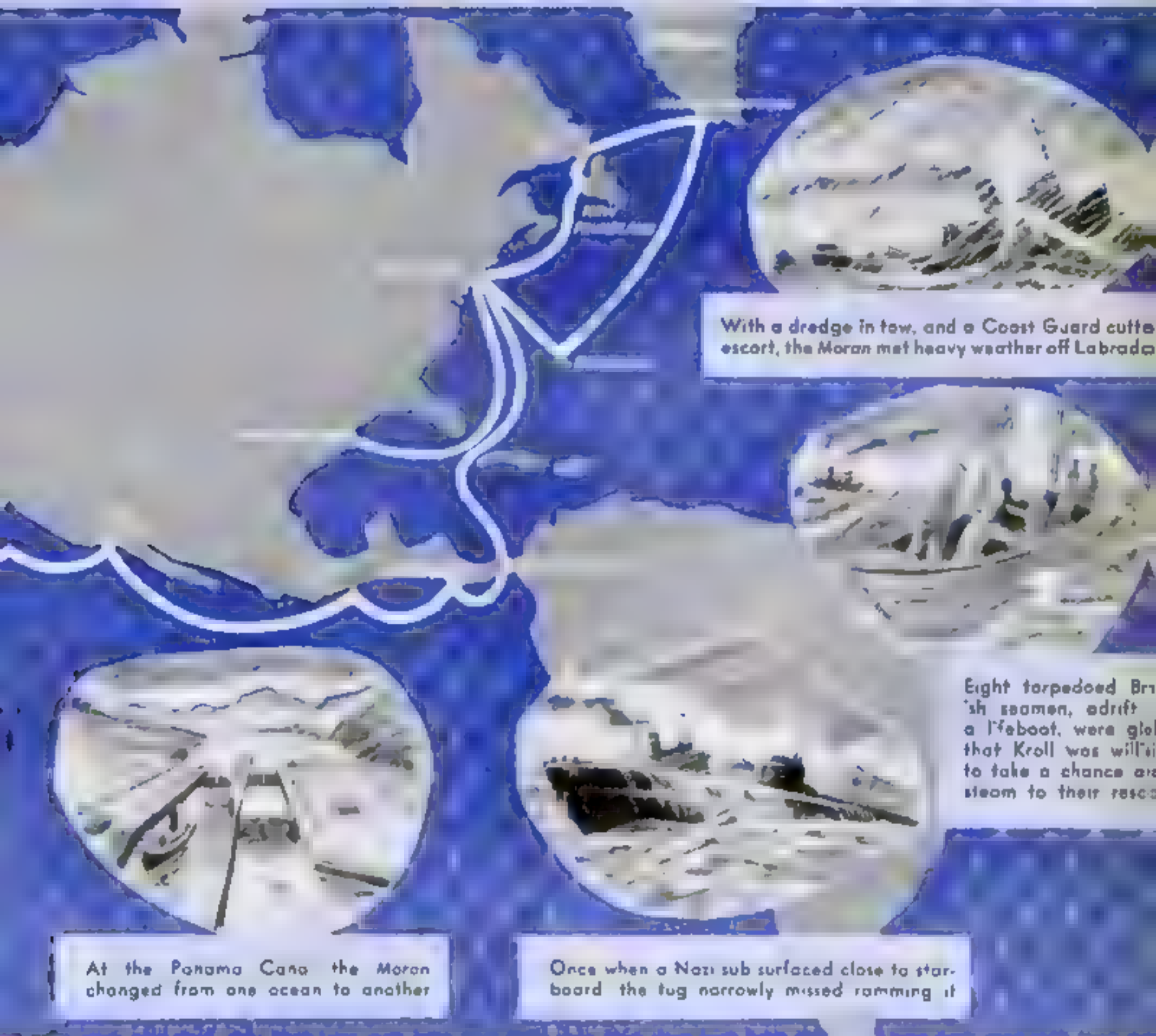
Along the Aleutians the tug moved big ships in the turbulent waters of strange harbors



The tough little towboat did not desert her charge when the ship was torpedoed



THE WAR TUG IN TWO OCEANS



With a dredge in tow, and a Coast Guard cutter escort, the Moran met heavy weather off Labrador.

Eight torpedoed British seamen, adrift in a lifeboat, were glad that Kroll was willing to take a chance and steam to their rescue.

At the Panama Canal the Moran changed from one ocean to another.

Once when a Nazi sub surfaced close to starboard the tug narrowly missed ramming it.

INSIDE STUFF ABOUT CAPTAIN KROLL'S TOWBOAT

FROM stern to stern she's only 11 feet longer than the 110-foot wing spread of a Flying Fortress. Her 336-ton burden is less than twice that of the historic *Mainflow*. But the seagoing towboat *Edmond J. Moran* has often tugged a hundred times her own weight through two oceans during the last four years. Powered by two 950-hp. Diesel engines driving generators, she consumes upwards of 1,400 gallons of oil daily. She can make 13 knots without a load, but her cruising speed with a dredge behind her is from five to six knots. There is a powerful single three-blade propeller 10 feet in diameter, and there are 18 speeds, both forward and reverse. The self-adjusting two-inch cable, 230 fathoms long, shown at the right, pays out from a drum between guides. Her hull is covered with $\frac{5}{8}$ -inch welded steel plates. Fully fueled, she draws 14½ feet of water.



Cable drum operates automatically, paying out and retrieving as much as 50 feet to compensate for additional strain.

had become routine work then, and all seemed well that night, so the captain wrote his good-night orders and went to bed.

In the dark, restless water ahead, two submarines were waiting mercilessly for business. Shortly after midnight, Captain Kroll felt a slight concussion while lying in his bunk. He sent out inquiries and learned that a submarine had torpedoed a ship several miles away, but the tug's instructions were to proceed. Moonlight slipping through the scudding clouds, meanwhile, etched the big, lame liner behind him sharply against the horizon. And at 3:10 a.m., according to the log, the *Moran* reeled as though slapped by a suddenly ferocious sea, and her skipper hit the deck.

The second officer shouted that the tow-line had snapped. It was only a step from the Captain's stateroom to the pilothouse, but the feel of the deck beneath his feet told him that the liner still was tied to the tug. She was foundering wildly on the end of his 350 fathoms of line, with two huge, fresh gaps from torpedoes in her side.

"Slip the cable," Kroll shouted as he seized the wheel. Sparks flying from the afterdeck quickly assured him that the cable was running out to free the *Moran* from the submarine's target.

"Full speed ahead," he ordered, and the towboat's 1,900-horsepower engines shot her away.

For seven minutes, Kroll kept his old girl zigzagging to avoid surface fire, for he knew that the U-boat commander whose torpedoes had liquidated the liner would like to come back and sink the tug, too. Then he turned her back toward the sinking ship. As she crept closer, he swept the sea with a single bright beam of light, barely long enough to spot the sub, then blacked out again.

For the rest of the night, the *Moran* and the U-boat played tag relentlessly with more than a hundred lives at stake. By constantly maneuvering to keep the battered hulk of the British ship between the submarine and the tug, Captain Kroll shielded his little boat from the Nazi gunners while he found one, then another, of the liner's lifeboats and took their occupants aboard.

At 5:10 a. m., he lined them up on the tugboat's tiny deck and counted them. He had saved 89 men and the woman. Where was the 90th man?

He was a Hindu sailor, the rescued crew said, who had deliberately refused to take to the lifeboats with them. He was determined to ride that ship into another world. Dawn was breaking, and it might be a dangerous waste of the precious few remaining moments of darkness to try to save him.

Kroll turned back to the wheel. As the ashen dawn gradually brightened, he could see the fatally wounded ship more and more clearly. She was gallantly but vainly resisting the overwhelming force of the sea. The throng of men whom he had just taken aboard the tugboat that was built to accommodate a crew of only 18 crowded around the wheelhouse, frantically begging him to speed them to safety. The submarine might spot and knock out his old girl at any minute. Why risk his own and a hundred other lives to save a single stubborn Mohammedan?

"Be calm," he told his jittery passengers, as he reached for his pipe. "If he is alive, we'll get him. We won't leave until he is aboard us or dead."

So the *Moran* edged closer to the liner that was about to vanish. The big ship's bow was pointed sharply skyward. And there stood the Hindu, with a fresh, clean turban properly wrapped around his head, and a neatly packed suitcase in one hand, ready for a one-way trip out of this world.

"Come on, jump!" his shipmates shouted wildly at him. The men on the *Moran* were ready to throw lines to him. But the Hindu was as indifferent as a man dozing on a veranda might be to children shouting at him.

Captain Kroll dared not go any closer. And the survivors jammed on the tiny tugboat alternately cursed the Hindu and the skipper who had just rescued them.

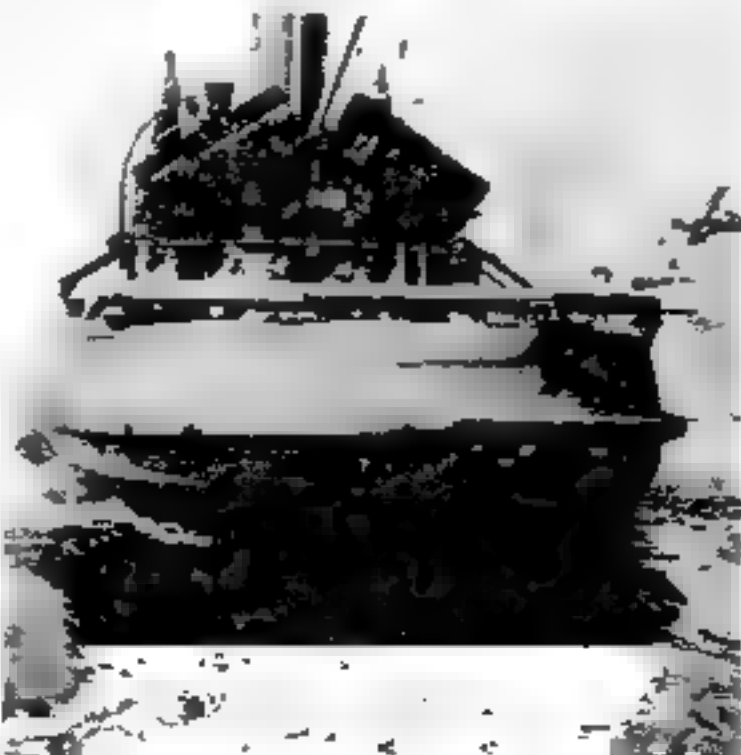
"I tell you it was comical," the Captain chuckles now. "There was that crazy fellow, waiting for us to come and take him off in style, and behind me his shipmates. That fellow wouldn't jump, they said.

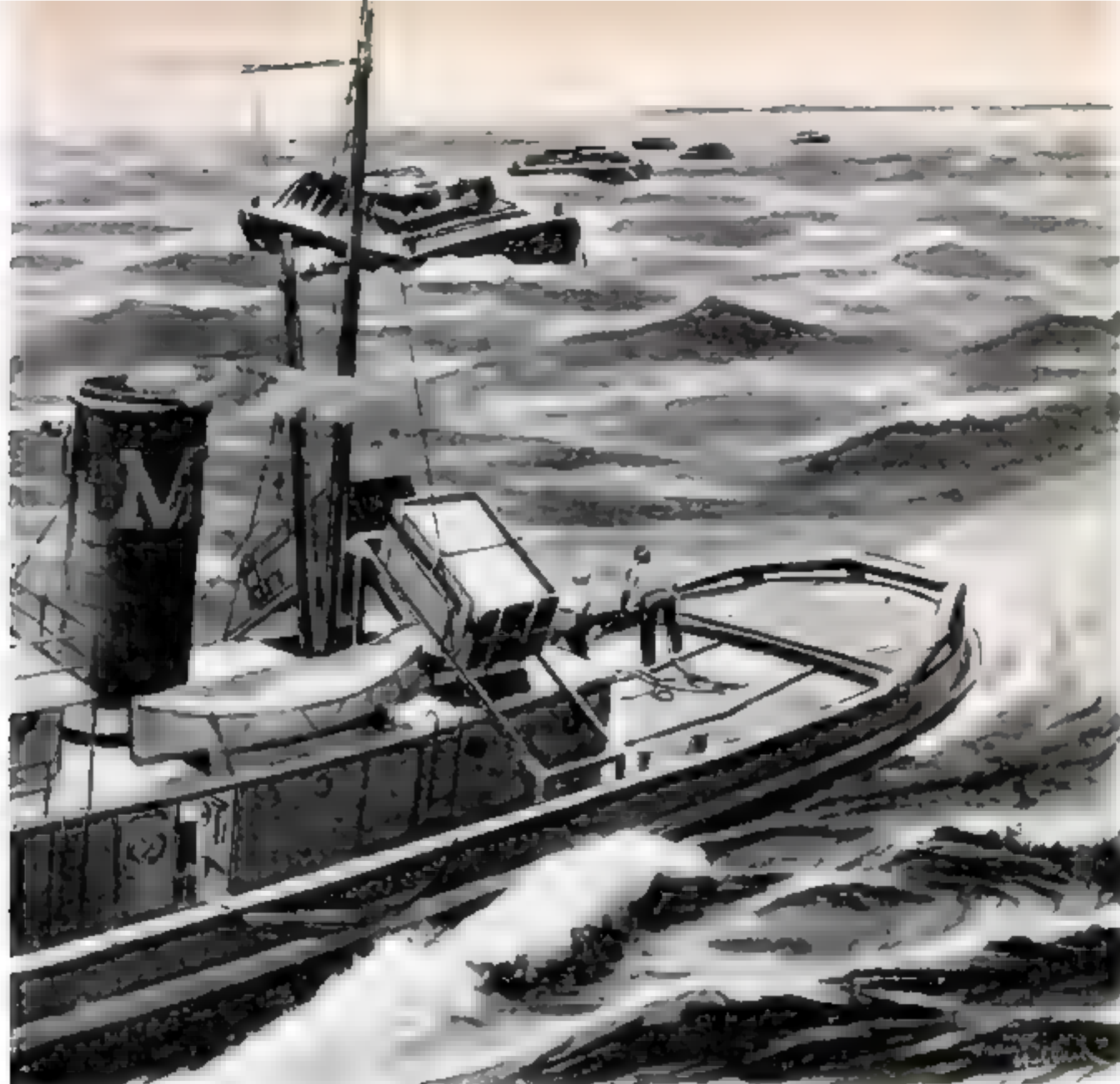
"Then the torpedoed ship began to go down fast. We couldn't do anything, but we were not going to leave until we saw that Hindu go down with her. At the last possible minute, he did jump. We got a line to him and hauled him aboard.

"He turned out to be a nice fellow, too."

By then, it was seven o'clock. The *Moran* ran down and smashed the lifeboats, then darted for shore to land her 91

The rounded stern of the *Edmond J. Moran* sits low in the water and is ideal for towing. The cable is paid out and recovered over three rollers. The rack shaped like an inverted V holds life rafts for the crew





One of Captain Kroll's cleverest tricks was the supplying of food to over 3,000 American soldiers marooned on an island in the Aleutians. He towed wooden barges to a point from which the current would carry them ashore undetected by the Japs

unexpected passengers. One of Captain Kroll's former bosses, telephoning to congratulate him, asked him if it had not been a hard night.

"Well, yes," said the tugboat mariner. "It's a tough job to serve breakfast to 91 extra people aboard my old girl."

After this and other brushes with oblivion on the Atlantic, the *Edmond J. Moran* and a kindred tug, the *Peter Moran*, were assigned to tow the world's biggest suction dredge to Panama. Its 42-inch sucker was needed there to keep the canal clear. Hawsers broke repeatedly, raging combers tore the deckhouse loose from the machine, depth charges dropped to drive off a submarine cracked the sea valves, and Captain Kroll once had to let 20,000 gallons of oil drip out of his stores to smooth the troubled waters for his tow, but the \$3,000,000 dredge was delivered. And that's how the captain hap-

pened to go to Alaska—quite unexpectedly.

"We just went out," he explains, "and when we found something to do we did it."

Near Panama, there was a German freighter to be towed to Salina Cruz, Mexico. There, the *Moran* found a 10,000-ton liner that needed a tow to San Pedro, Calif. There, "very important orders" from the Army Transportation Corps sent the tugboat on toward Dutch Harbor with two barges in tow. Captain Kroll expected this trip to be a ten-day cruise, but he did not see Seattle again for 15 months.

As the Americans advanced along the Aleutians toward Tokyo, the tug ran supplies, docked big ships in the turbulent waters of strange harbors, and pulled more than 50 barges, boats, and freighters off rocks where storms had tossed them. At Attu, the *Moran* landed supplies for our forces in Holtz (Continued on page 254)

Can We Meet the Robot's Threat?

How Automatic Weapons

Crewless planes . . . mechanical brains that think faster than man . . . remote-controlled bombs with new, superpower explosives . . . vengeance-wreaking automatons designed for mass murder . . . guns that can't miss . . . instruments that see through clouds and darkness—these new terrors imperil the peace of the future.

By **ALDEN P. ARMAGNAC**

Drawings by **B. G. SEIELSTAD**

WILL death-dealing automatons, sooner or later, imperil the lives of everyone? Long-secret war weapons, now brought into the open, raise the startling question. They see through clouds and the darkness of night, when human eyes are blind. Faster than a man can think, their mechanical brains perform intricate calculations and aim guns against swiftly moving targets. They blast objectives with a ton or more of high explosives from more than 150 miles away. Stranger even than the fiction of a Jules Verne or an H. G. Wells, they still offer only a preview of what war may be like in days to come.

Germany's "vengeance weapon" V-1, a jet-propelled "flying torpedo" or robot bomb, became a grim reality to Londoners last June. While the long-range gun that bombarded Paris in the last war fired a projectile weighing only 264 pounds overall, V-1 carried no less than 2,200 pounds of high explosive alone. Moreover, the flying torpedo boasted more than twice the range of the shell. Once launched from a ramp in the general direction of London, it followed a more or less direct course, wind permitting, under the control of a simple gyro pilot. Then, any sort of timing control—a clock, or exhaustion of a measured quantity of fuel—tilts the infernal machine into a dive to earth. A firing pin clicks, and the full force of the explosion rends whatever is hit.

A devilishly ingenious automaton, this—difficult enough for speedy fighter planes or antiaircraft guns to shoot down in clear daylight, let alone fog and night. Its only fault from a humane point of view was that no one knew where it would land. Guns and bombing planes can score amazingly accurate hits on legitimate military objectives. But practically all the targets of the V-1, considering its extreme range and random point of fall, naturally have included such nonmilitary items as a queue of children waiting to board an evacuation train; theaters, hospitals; and the vast expanse of dwellings of ordinary workers. Knowing

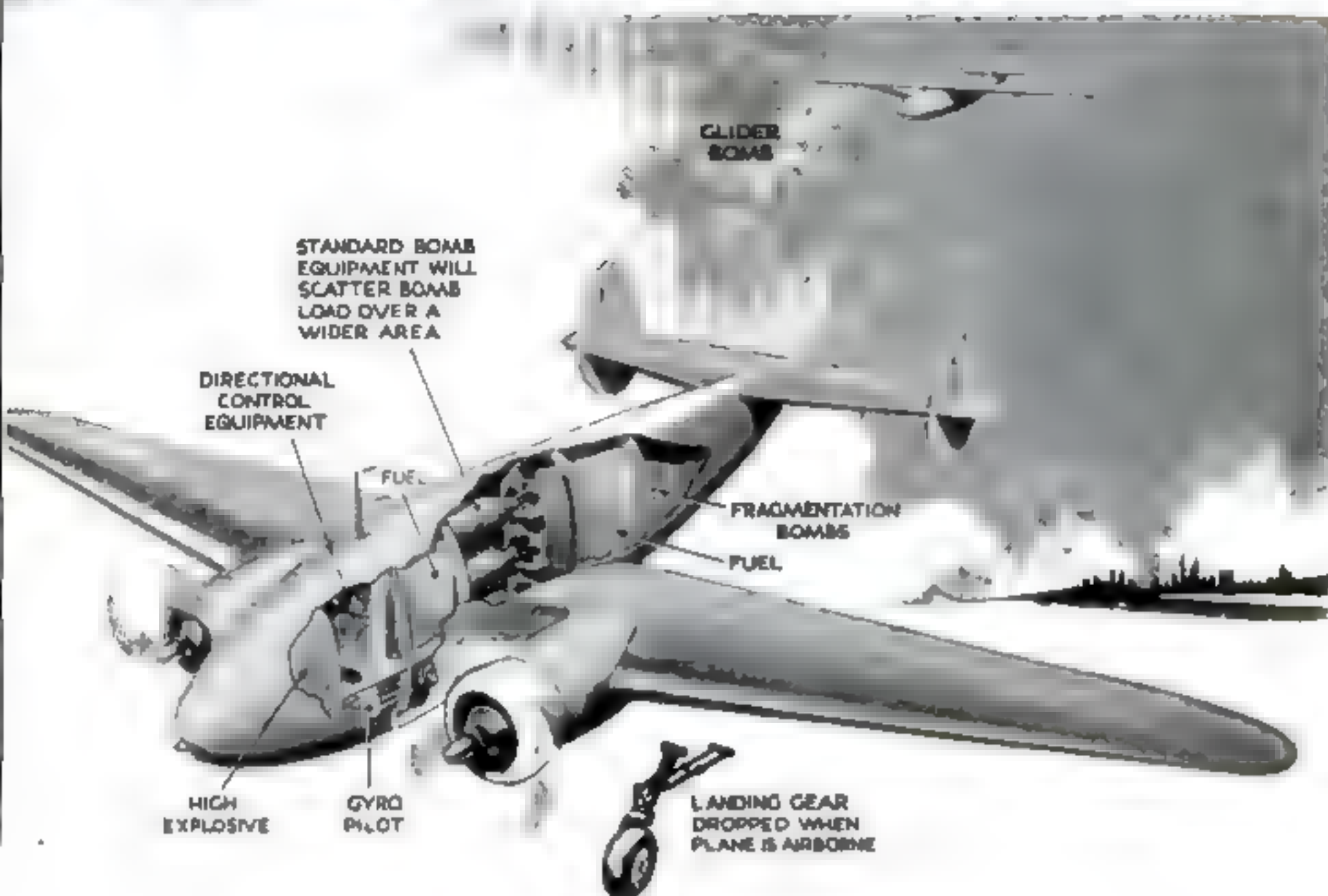
this, the Germans obviously adopted a policy of indiscriminate bombing. They took what satisfaction they could from the fact that, in the first seven weeks of bombardment, flying torpedoes killed 4,735 men, women, and children, and seriously injured 14,000 more. Compared with London's aerial "blitz" of 1940-41—when German bombers, given the benefit of the doubt, possibly tried to hit war centers—the V-1 exacted a daily death toll two thirds as high.

Here was the first open declaration of war—or, if you prefer, of mass murder—against a whole population. Of course, in this case, Germany will regret it. But it set a terrifying precedent for any conceivable war of the future. The spectacle of great nations bent on exterminating each other, failing intervention of a world police force, seems neither incredible nor too remote to contemplate. Crewless and remote-controlled weapons of today suggest some of tomorrow's ruthless engines of war.

Fighting robots with robots holds dramatic possibilities, some of them already realized. Imagine, for example, that a German plant making flying torpedoes is to be bombed on a certain day. Allied raiders find the target heavily blanketed with clouds that no human eye can pierce. But they are prepared for that. In the leading plane, a "robot eye," or fog-piercing telescope, gives a cloudfree image of the target. Just at the moment that the bombardier would normally let go with explosives, he releases a smoke bomb that forms an air marker. Following planes simply drop their bombs through the hole in the smoke ring to score bull's-eye hits. At night, parachute flares replace plain smoke. Remarkable successes have been credited to American and British airmen using the new technique, which is based upon research by scientists of both countries. In case enemy planes should attempt to lay false air markers and thus mislead our bombers, colored smokes and flares may be used, and the hue changed like a countersign from day to day.

No doubt every Nazi, boiling with helpless rage at the havoc wrought by made-in-U.S.A. bombs, has longed to see New York hit by flying torpedoes. On a token scale,

Are Changing Warfare



Pilotless planes, loaded with explosives and towing gliders with more, may cross oceans to strike large target areas. This is our artist's conception of an actual present-day plane equipped for such service.

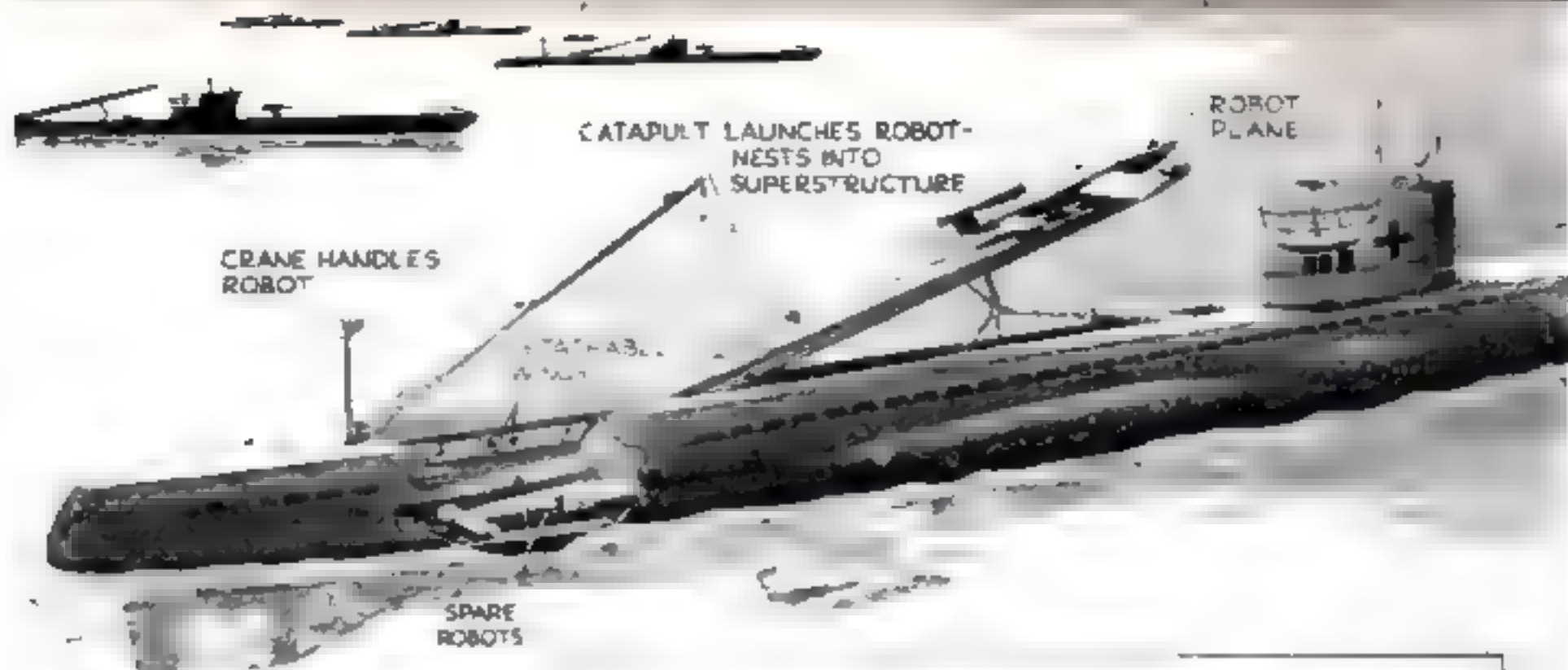
It might be tried, if the Germans considered the attempt to be worth the risk. For this purpose, at least, there need be no question of transatlantic projectiles. Submarines have carried manned airplanes, and could transport winged torpedoes as easily. A retractable launching ramp on deck should impose no difficult engineering problem. Standing 50 to 100 miles offshore, with ramp erected and a V-1 in place, a U-boat could bombard the world's greatest port with a fair chance of hitting something, somewhere. But to launch its flying torpedo, the submarine must surface. And that is taking the dangerous chance of being spotted by radar equipment on warships and patrol planes, which would make short work of it. Again, robot versus robot.

If a Messerschmitt 210 happened to tangle with a B-29 Superfortress, you might witness the extraordinary sight of unmanned turret guns firing at each other.

Comfortably seated at the best vantage points of the plane, gunners fire their weapons by remote control. Manipulating a handle bearing an electrical sight automatically turns a distant turret, and trains its guns, by means of "selsyn," or power-amplifying, mechanism. The scheme eliminates possible blind spots where a gunner might fail to see a hostile plane approaching his arc of fire.

Here is an interesting note on future war weapons: The intricate sights that guide a bomb to its target, as used by Allied flyers, now have "zero error." In other words, they operate with such extreme precision that no possible improvement would be of practical use. Such factors as split-second mechanical lag in bomb-release mechanism will take precedence for future research.

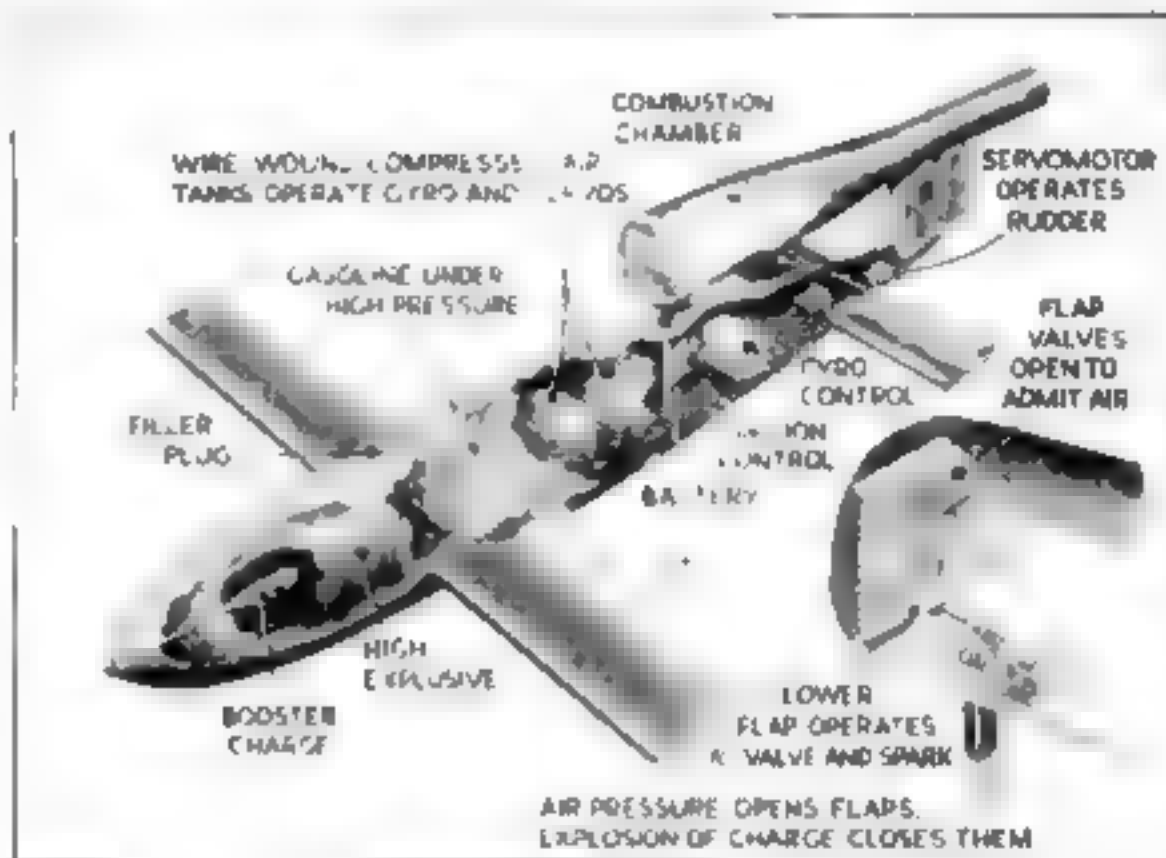
"Here it comes—there it goes" describes what antiaircraft gunners are up against, when they try to hit V-1's and the even speedier fighting planes. By the time a pro-



"Flying bombs" like those that hit London could be launched against U.S. seaboard areas from submarines lying 50 to 100 miles offshore. Retractable ramps would be used as visualized in the drawing. Details of the Nazi vengeance weapon, based on latest data, are shown at right

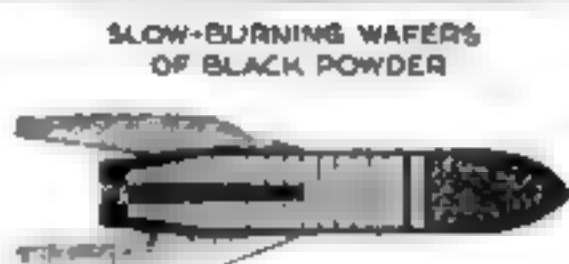
jectile reaches the altitude of a bomber flying 20,000 feet high, the plane will have traveled a mile. And in the time it would take a human brain to calculate where the gun should be aimed, the target would long since have vanished

Therefore, mechanical or electrical brains, called directors, instantaneously compute the firing data for antiaircraft crews and for aerial and naval gunners. Once these complex thinking machines, among the most

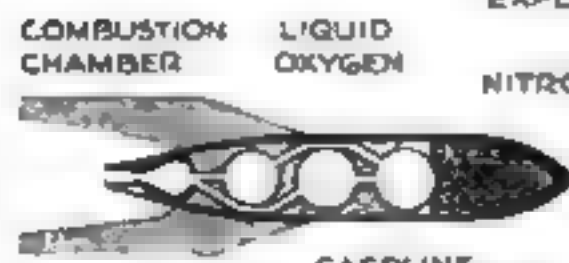


intricate pieces of war equipment, seemed to defy production in quantity. But U. S. output in the two-year period between December, 1941 and December, 1943 increased by 3,000 percent, according to a recent an

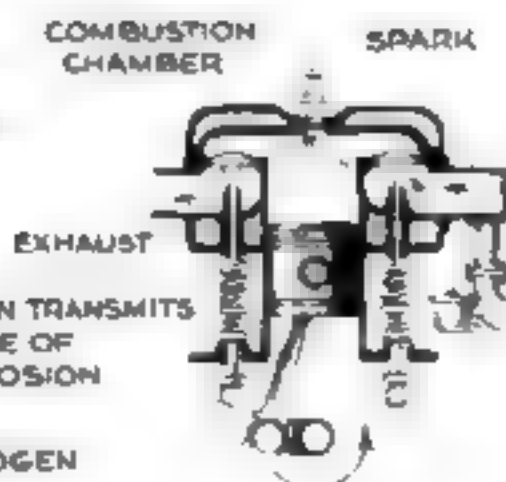
ROBOTS GET THEIR DRIVE BY HARNESSING EXPANDING GASES



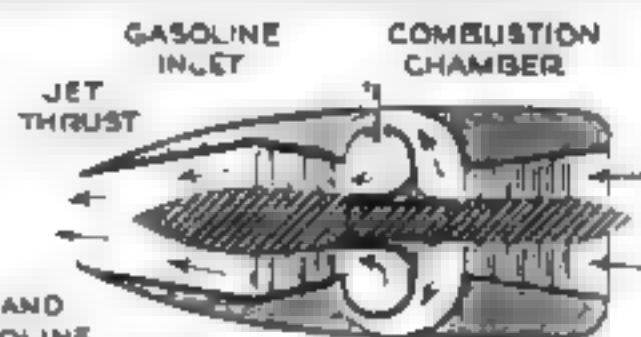
SOLID-FUEL ROCKET



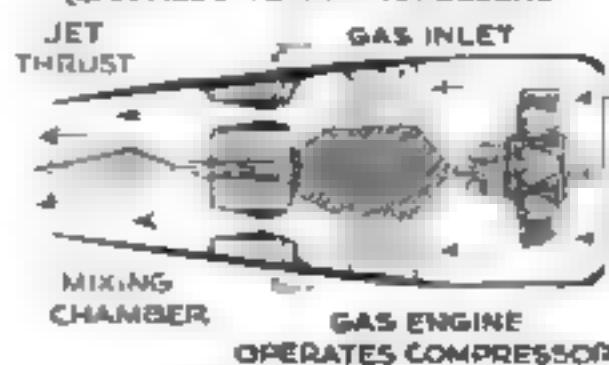
LIQUID-FUEL ROCKET



INTERNAL-COMBUSTION ENGINE USES SAME BASIC PRINCIPLE AS LIQUID-FUEL ROCKET AND JET ENGINE, BUT APPLIES FORCE OF EXPLOSION MECHANICALLY INSTEAD OF THROUGH JET THRUST AGAINST AIR



JET ENGINES
(CAN ALSO TURN PROPELLERS)



nouncement by the Navy Department. And with each new model, gunfire becomes more automatic. Unaided by human hands, the gun aims itself and sets the time fuses of its projectiles; the crew need only fire the gun, and keep ammunition racks loaded. Marvels like these make it possible to imagine a future robot gun with no crew at all.

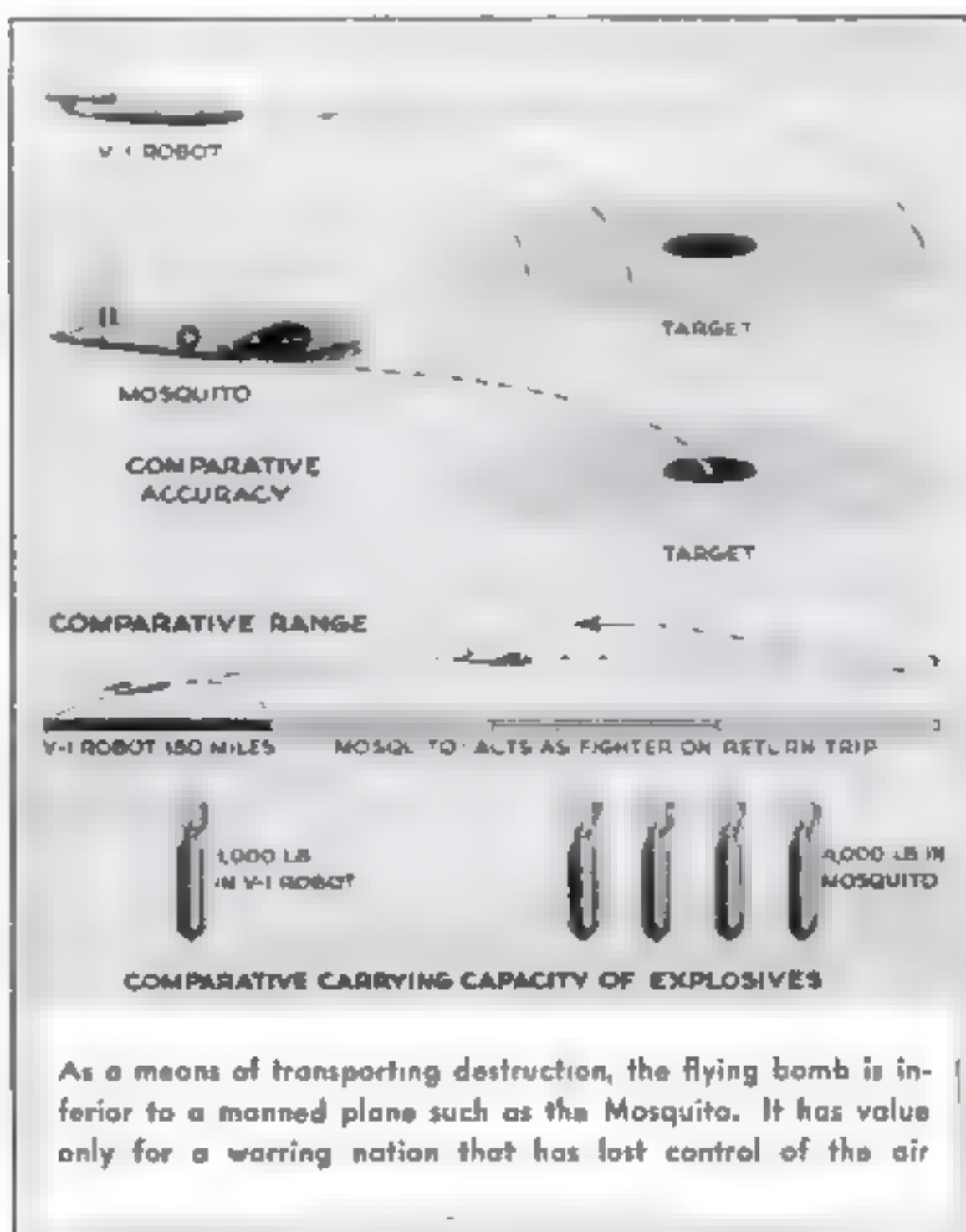
One of the war's strangest air stories tells of a "ghost plane"—a flak-riddled Liberator bomber—that accompanied other homeward-bound raiders in perfect formation. Close-up observation revealed no man at the guns or controls; all of the crew must have taken to parachutes or have been killed. Calling his base for instructions, as the group neared England, a worried flight officer was told to shoot down the Flying Dutchman of the air. Before he could obey, it apparently ran out of fuel, for it banked into a graceful curve and slipped beneath the waters of the English Channel.

Beyond doubt, the invisible hand at the controls was the gyro pilot, familiar to airmen since long before the war. Originally it consisted of a pair of gyroscopes, constantly maintaining a fixed position in space. When the plane tipped or turned, the gyroscopes actuated a pneumatic-hydraulic linkage that operated the rudder, elevator, and ailerons to bring the craft back to its true course. By handing the plane over to the gyro pilot, which needed only occasional correction, the pilot could free himself to take navigation observations, transmit and receive radio messages, or just plain relax. Now it has just been announced that, since shortly after Pearl Harbor, Flying Fortresses have been provided with a supersensitive gyro pilot which operates by electronic control from the gyros. At the start of a bombing run, the bombardier takes over control of the gyro pilot, which has been set to a straight course over the target. If the setting is a trifle off, the touch of a finger swerves the plane just a little to the left or right—enough to increase direct hits by 25 to 30 percent.

Some time before Germany's introduction of the gyro-controlled flying torpedo, the Nazis demonstrated another way of guiding crewless missiles with their radio-

controlled glider bomba. Intended for attacking vessels at sea, the glider was steered by a radio transmitter in a distant powered plane, until, if all went well, it crashed upon the deck of the enemy ship. When it repeatedly failed to do so, the experiment apparently was abandoned, for nothing more was heard of the weapon.

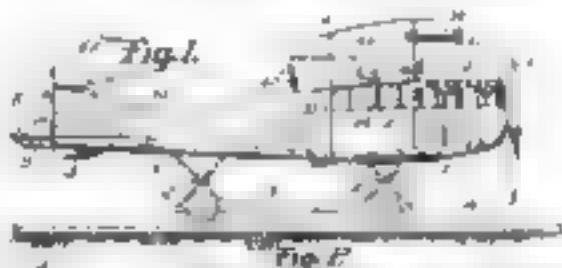
For the record, it may be mentioned right here that neither gyro-controlled nor radio-controlled airplanes are new to Americans, nor to the British. Before the end of World War I, the U. S. Navy was flying experimental crewless bombing planes with gyro control, said to be better than that of the V-1. Within the next few years, patents on gyro and radio planes were applied for by John Hays Hammond, Jr., Elmer A. and Lawrence B. Sperry, Charles F. Kettering, and other notables of the scientific and inventive world. Two facts probably explain why the robot bomber was dropped—our air forces' repugnance to the risk of hitting innocent civilians, and their desire to save their explosives for more worthwhile targets. Both America and Britain developed radio-controlled planes, but for use only as flying targets, as far as records show. Likewise, the ex-battleship *Utah* and one or more destroyers have served as radio-controlled



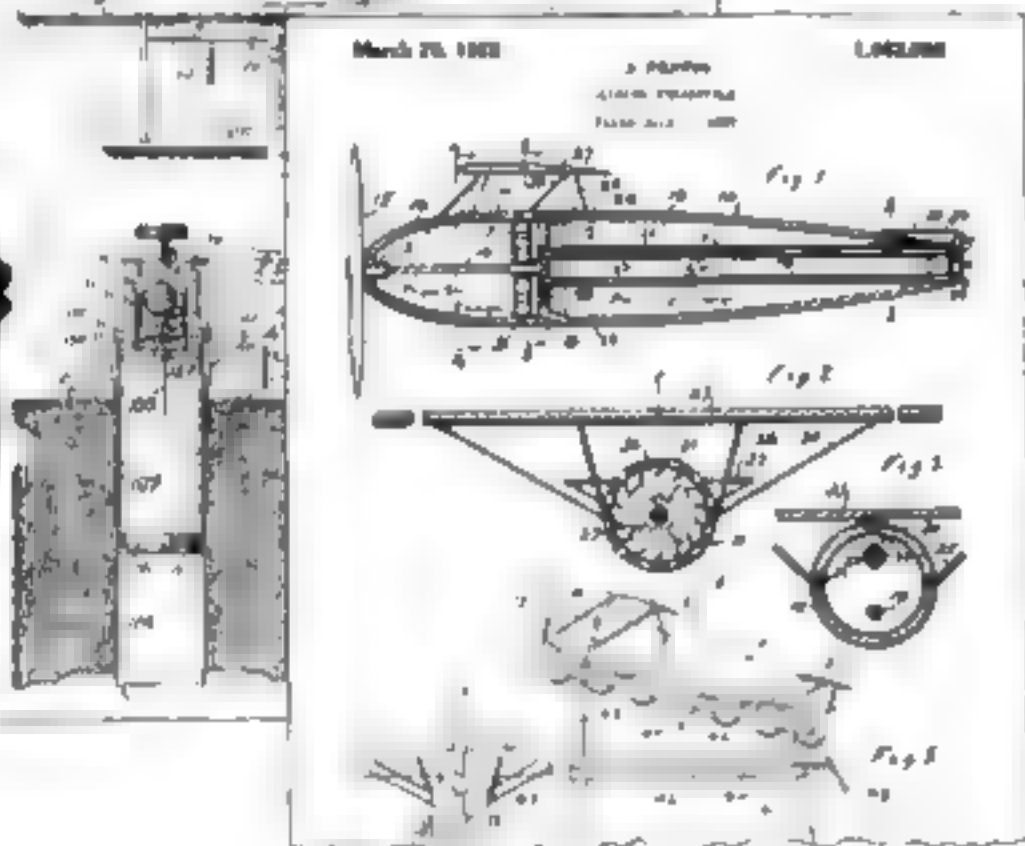


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ROBOT PLANES ARE NOT NEW. Twenty-five years ago, the Madisette "Hot Shot" used timing gears to fly itself over a target area, release bombs, and fold up into a crash. Our Navy tried out crewless planes in World War I. Since then, inventors such as Hammond, Kettering, and the Sperrys tackled the problem

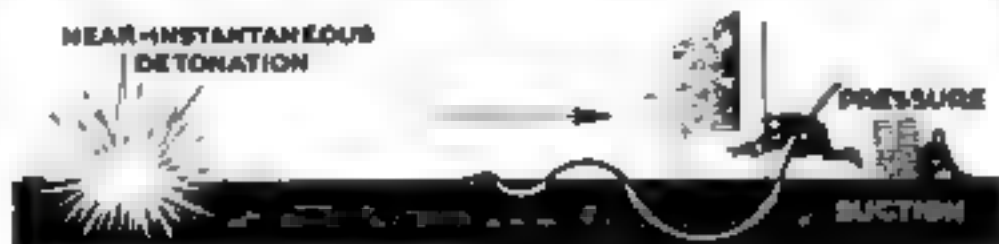
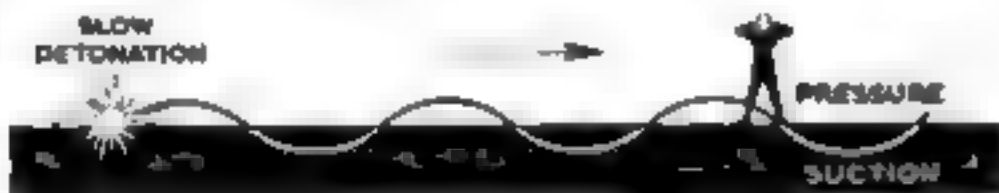


targets for Navy guns and bombs.

To return to the current battle-front, a radio-controlled German "tank," more interesting for its novelty than its military value, has also appeared on the Italian front. Its driver steers the 12-foot-long vehicle as near the enemy as he dares. Stepping out, he guides it onward by a portable transmitter. At its destination it stops and drops a time-fused, 800-pound explosive charge. Then its driver calls it back by radio, and makes his getaway. Details are lacking as to what the explosive is intended to do, and why

Mobile land mines, resembling

NEW EXPLOSIVES BRING NEW PERIL. "Blast effect" produced by the near-instantaneous detonation of recently developed explosives calls for new precautions on the part of civilians for self-protection



12,000-POUND BOMBS, like the RAF "cookie" below, set a new high-water mark in destruction. Before-and-after photos at right show what just a few of these babies did to the Gnome-Le Rhone aero-engine works at Limoges, France, in a visit by the Lancasters



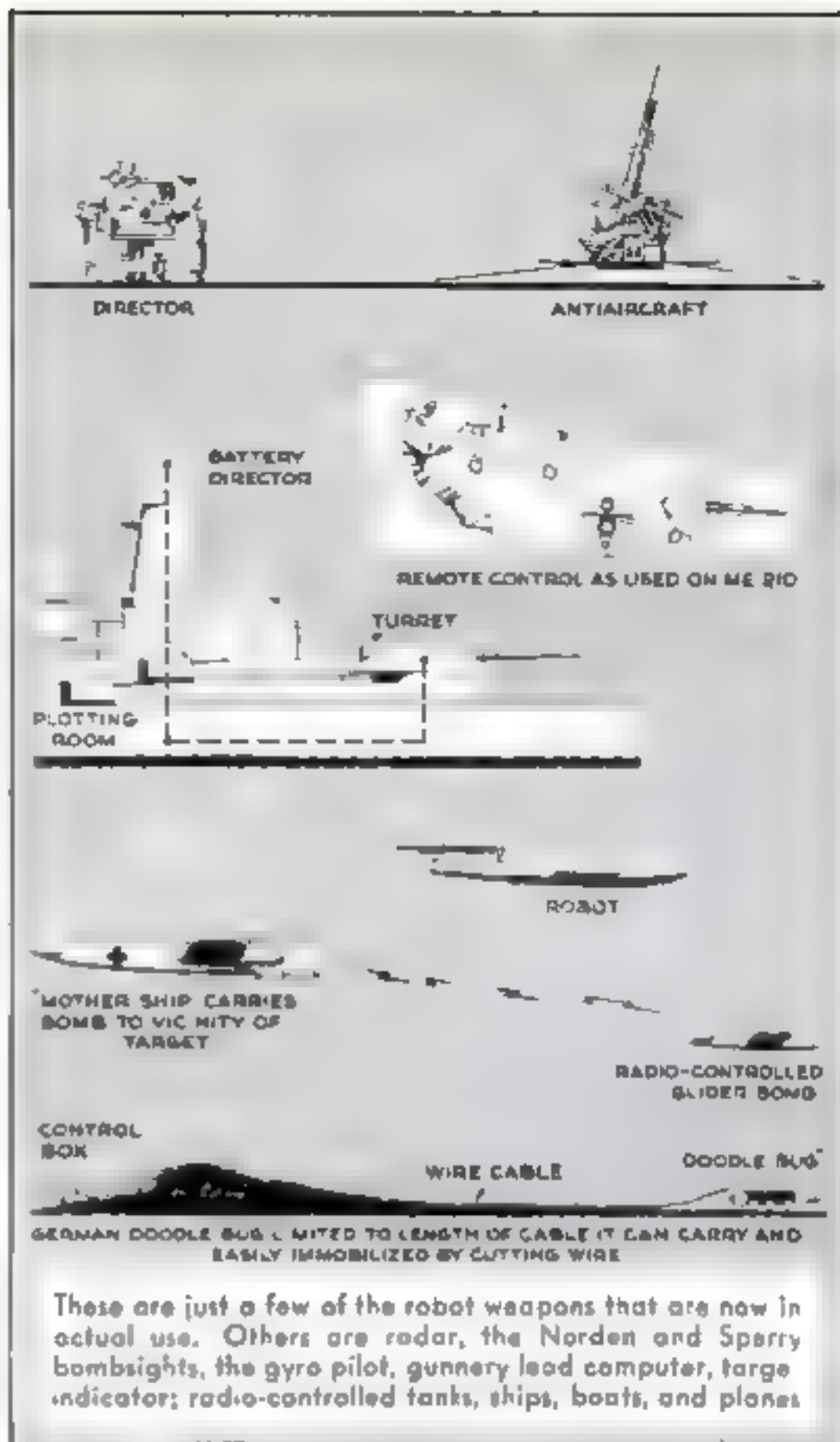
toy-sized tanks and stuffed with 250 pounds of explosives, exhibited an even simpler method of remote control at the Anzio beachhead in Italy. Propelled by self-contained electric motors, under power received through trailing cables, they were designed to be exploded by the operator as they scuttled beneath barbed-wire entanglements or among invasion troops. Delighted with the new targets, Allied gunners went to work on them in a shooting-gallery mood. Not one of the robots escaped. Those that were not blown up made amusing, if battered, souvenirs. Hunting was better when the Allies invaded France, where numbers of intact "doodlebugs" were found abandoned by the Germans.

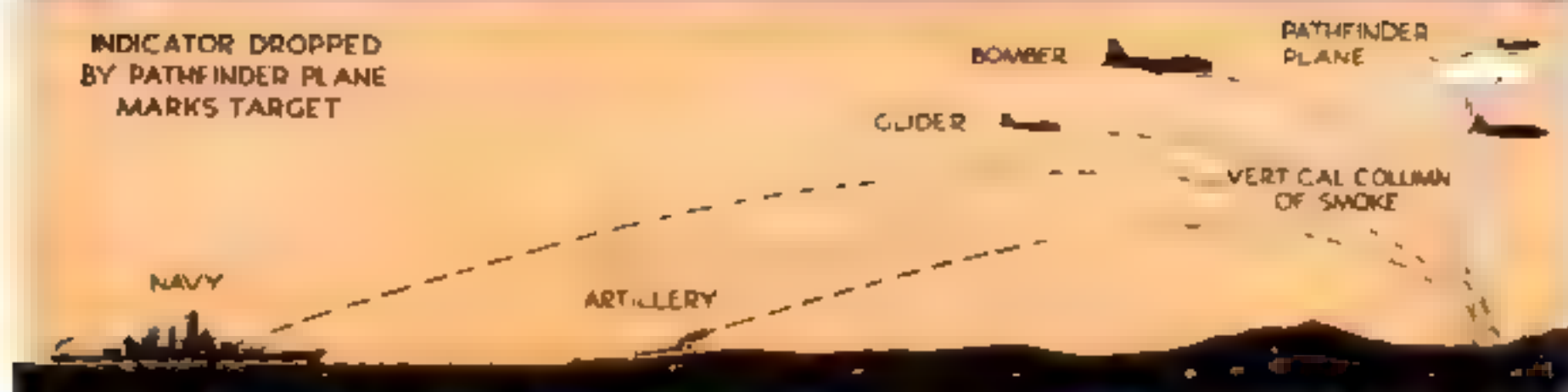
A meal that cooks itself probably ranks as the favorite robot of the average GI. After punching holes in the top of a food can, he ignites a packaged charge of fuel extending down a central compartment. In four minutes the contents are steaming hot and ready to eat. The enemy may find this one of the deadliest of Allied robots—for who will deny that a well-fed American soldier can lick his weight in wildcats?

Special weapons deal with some enemy robots. For example, fields sown with land mines have allowed Axis forces to retreat in time to avoid destruction. Allied pursuit has had to wait until a pathway has been cleared of mines and marked. Now, however, vehicles acting as mine destroyers lead the way straight through the danger zone. Revolving drums in front of them beat the earth with flails of heavy chain, exploding the mines a safe

distance ahead of them. One British type, designed for this sole purpose, might be called a land minesweeper. Tanks have also been equipped with the flailing apparatus.

Next to the use of automatons, revival





Clouds can't hide a target from bombers, artillery, or airborne troops. A fog piercing "robot eye" in a pathfinder plane picks up the objective. Pathfinder drops bombs that trail a stationary column of smoke

of rocket weapons has furnished one of the major surprises of the current war. The rockets whose "red glare" has been immortalized in our national anthem were not signal rockets, but the first effective military rocket, devised in 1806 by Sir William Congreve and used by the British in the War of 1812. But war rockets gave way to rifled guns of superior accuracy. It remained for modern designers to give rockets at least fair accuracy, so as to make the most of their outstanding advantages—absence of recoil, and light weight in comparison with artillery of equal firepower. So well have they succeeded that rockets bearing ex-

plosive or incendiary charges have become indispensable weapons in the air, at sea, and on land.

About the beginning of this year, American warplanes such as the Grumman Avenger began

hunting U-boats with rockets, particularly suited to the purpose because the propelling tube continues to drive its explosive head under water. British pilots of speedy Typhoons have specialized in low-altitude, high-speed rocket attacks on enemy tanks, with devastating results. Rocket duels between planes have occurred beyond bullet range. Against Japanese troops and ground installations in the China-Burma-India theater, Allied dive bombers have launched rockets from 4½-inch "flying bazookas" with pin-point precision. In one of the latest designs, planes fire rockets in clusters of three, mounted beneath the wings.

How to keep an invasion beach clear of defenders, during the fateful moments between the end of a naval barrage and the landing of the first assault wave, has been a problem solved by the Navy with rockets. A bit longer than three-inch shells, they packed explosive power almost equal to that of a destroyer's main battery. For use, they were carried in racks flanking an armored cockpit-bridge, in special landing-support

RADAR vs. RAIDER. Here our artist gives you his idea of the way robots foil night bombers. Long-range radar picks up the intruder and guides a night fighter close enough for his own short-range radar to take over the job. Inset at left shows the AAF's new P 61 night fighter. [See cover painting]



craft, and were fired from the racks at an upward angle of about 45 degrees. In action, the support craft flanked the troop carriers or followed their dash to shore, shooting over them and transforming the beach into an inferno of exploding rockets. Shell casing carried with the rockets made effective shrapnel. The rocket treatment definitely discouraged the enemy from leaving their shelters and mowing down the first invaders

to come ashore, largely accounting for the success of American landings in Jap-held areas of New Guinea, New Britain, and other Far Eastern objectives. Improved rocket craft, whose armament and details remain to be made public, are now in Navy service. The recoil of guns capable of giving comparable results would crash through the flat, thin bottom of the landing-support boats like a [\(Continued on page 236\)](#)

MECHANICAL IMPROVEMENTS KEEP PACE WITH ROBOT WAR

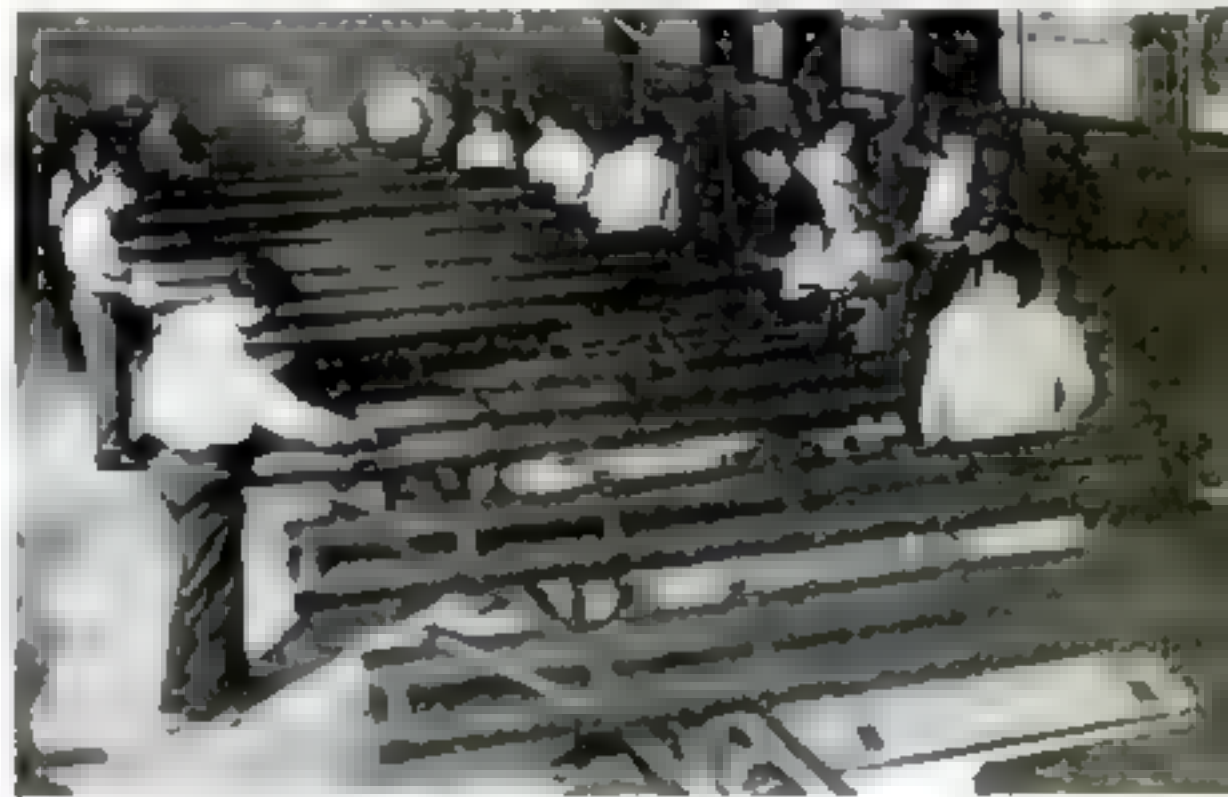


NEW FIGHTER. Look again! It's not the Bell P-39 Airacobra, but its big brother, the P-63 Kingcobra. Bigger all over (wing span is four feet greater than that of the P-39) and with a higher and sharper tail, it has 50 percent greater range, nearly 35 000-foot ceiling, and a speed close to 400 m.p.h. Its armament consists of two .50 caliber machine guns under the wings, two more in the nose, and a 37-millimeter cannon firing through the propeller. The wing is of laminar-flow design. A two-stage supercharger is used to give the 1,500-hp. Allison engine its superb performance at high altitudes

WEASEL is the word for the Army's new M-29 personnel and supply carrier. Light weight and broad tracks carry it across snow, mud, and sand. Built by Studebaker



BAILEY BRIDGE, the invention of a Britisher, uses interchangeable parts for a quick answer to enemy demolitions. It has speeded the advance of Allied troops in France and Italy



"FLYING BAZOOKAS," giant three-barreled rocket launchers, being assembled here by General Electric, are attached to wings of dive bombers. The British "Baron" tank below flails the ground ahead with chains to set off land mines



Will Airborne Police Enforce World Peace?

PARACHUTE AND GLIDER TROOPS, WITH NEW TACTICS AND EQUIPMENT DEVELOPED BY THE ALLIED NATIONS, MAY BE THE MEANS OF PREVENTING WORLD WAR III

By VOLTA TORREY

ADDITION of a vertical flank to America's armies has hastened victory. Napoleon could not cross the English channel, but General Eisenhower could—with the help of airborne divisions. In the Orient, too, these "sons o' guns with tons o' guns" have literally leaped forward. Flying infantrymen are one of this war's most spectacular and significant developments, and may be a means of preventing a third world war.

"The day will most assuredly come," says Maj. Gen. F. A. M. Browning, commander of Britain's first airborne division, "when airborne armored forces will control the world, and the inhuman, though at present inevitable, bombing of women and children, inherent in strategic bombing, will be a barbaric relic of the past."

The Nazis staged the first airborne assaults, but their invention has boomeranged.

The Berlin gangsters had been impressed by the mass parachuting of Russian soldiers; the Germans already had developed gliders because they were forbidden to build warplanes. By parachutes and gliders, Hitler dumped 35,000 men—an army as big as George Washington's—into Crete and took that Mediterranean isle. The Nazis made many costly mistakes. But American and British officers saw that those errors could be avoided, and that nearly everything that fights could be flown.

Quickly, Uncle Sam and John Bull then developed superior airborne forces. A vast array of new, light, and compact matériel was invented. New ways of stowing, landing, and assembling standard equipment were devised. And the techniques of both parachuting men and supplies to earth and landing military forces in gliders were improved.

There are now about twice as many glider-borne men as paratroopers in an

HOW TROOPS FROM THE SKY CAN QUELL AGGRESSORS

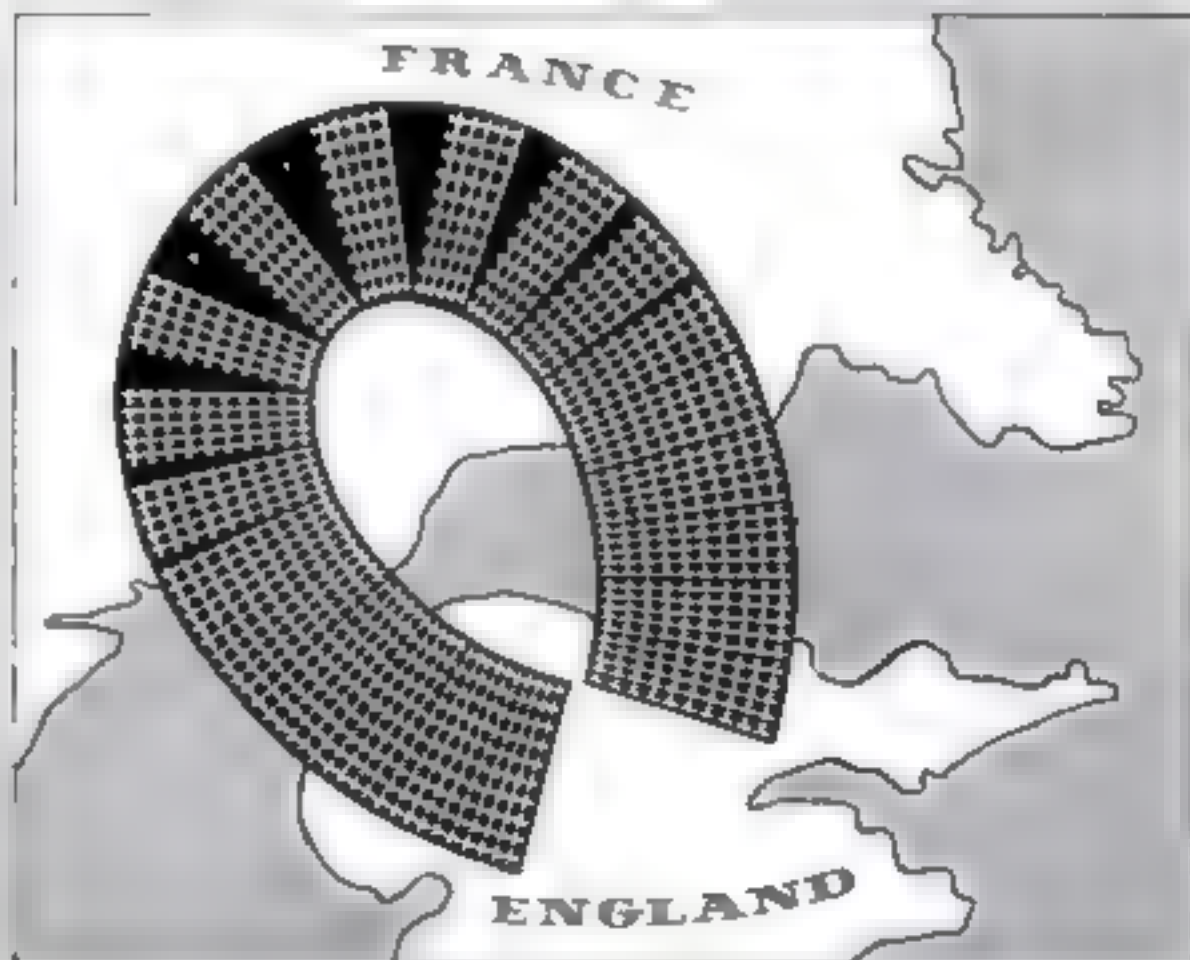
PEACE must be guarded. Plans for a world police force are being debated. An international air force has been proposed.

But, if another Hitler appears, must multitudes of innocent people again be bombed and great cities wiped out to destroy him and his henchmen?

We have learned in this war how to fly an army over military ramparts and hurl it directly at a carefully chosen target. Airborne divisions, although still in their infancy, have played stellar roles. Airborne forces can be much further developed.

A great airborne army, able to roam the sky with cannon and tanks, could function like a police riot squad. It could descend like lightning on any government that planned to make war. This may be the surest and most humane way to preserve world peace.

Because of the tremendous potentialities of airborne forces, **POPULAR SCIENCE MONTHLY** offers this account of their rapid growth, remarkable equipment, and recent achievements.



1,000 PLANES, in a great aerial serpent nine planes wide and 200 miles long, carried the airborne spearhead of invasion on D-day. As the head of the procession recrossed the English coast after dropping its paratroopers and gliders, the tail was still rearing outward



American parachutes dot a New Guinea landscape as our airborne troops, hidden in 12-foot grass, spring into action for a sudden surprise bow at Japanese forces

American airborne division
There are artillerymen, engineers, doctors, and numerous other specialists among these men. An airborne division now lands with literally everything from flame throwers to chaplains. It is really a miniature army that can be swiftly enlarged, as soon as an airhead is won, by landing transport planes full of additional fighting men.

Simultaneously with the creation of such divisions, new theories as to their use were evolved. The Germans had thought only of hit-and-grab raiding. American officers perceived the greater potentialities of teamwork between airborne and other forces, and have made airborne missions a razzle-dazzling feature of land and naval drives.

Generals could not learn to use airborne troops as they

SPECIALLY DESIGNED FLAME THROWERS COME DOWN UNDER THEIR OWN 'CHUTES



Identifying the flame-thrower parcel by the distinctive color of its canopy, a paratrooper races over to it and collapses the 'chute to keep the wind from dragging the bundle away



Hastily he pulls off the tape that holds the bundle together. This roll contains two complete flame-thrower units ready for use. Each unit weighs 68 pounds

Here one flame thrower has been removed from the roll, while the other remains inside. Note the felt padding on the inside of the parapack. This protects the equipment from being damaged in landing

The paratrooper throws the harness over his shoulder. This projector, known as the M-1A1, can discharge a flame lasting 10 seconds



MORE AIRBORNE MATÉRIEL ON FOLLOWING PAGES

HEAVIEST ORDNANCE DROPPED BY 'CHUTE



1 This is the paratroopers' heavy artillery—a 75-mm. howitzer crew with its piece ready to travel. The nine bundles, weighing from 250 to 310 pounds each, contain the parts of the howitzer, a supply of ammunition, and even a cart for hauling shells



2 Long, hexagonal boxes like this are slung in paracks on the bottom of the plane. Each box has a parachute which is stowed in the cupike shield at the front of the rack



5 The howitzer tube rides in this special box. The strong binding tape is cut when the bundle is opened



6 This is one of the smaller boxes, containing other parts of the gun, that go out the plane door. You can see how heavily the inside of the lid is padded



7 Within 6 1/2 minutes, the 75-mm. field piece is assembled and ready to fire. It is a regular mountain howitzer on a high-speed axle and rubber-tired wheels

learn to employ other forces, by studying the campaigns of Napoleon, Grant, and other military geniuses. But in Africa, Sicily, Italy, New Guinea, Burma, and France, American officers have become increasingly proficient in vertical envelopment

1 1/2-TON, 6 x 6 TRUCK RIDES IN CG-13 GLIDER

Backed in under the upraised nose of this motorless flying boxcar and lashed down securely a powerful truck can be flown in to an objective ready for action



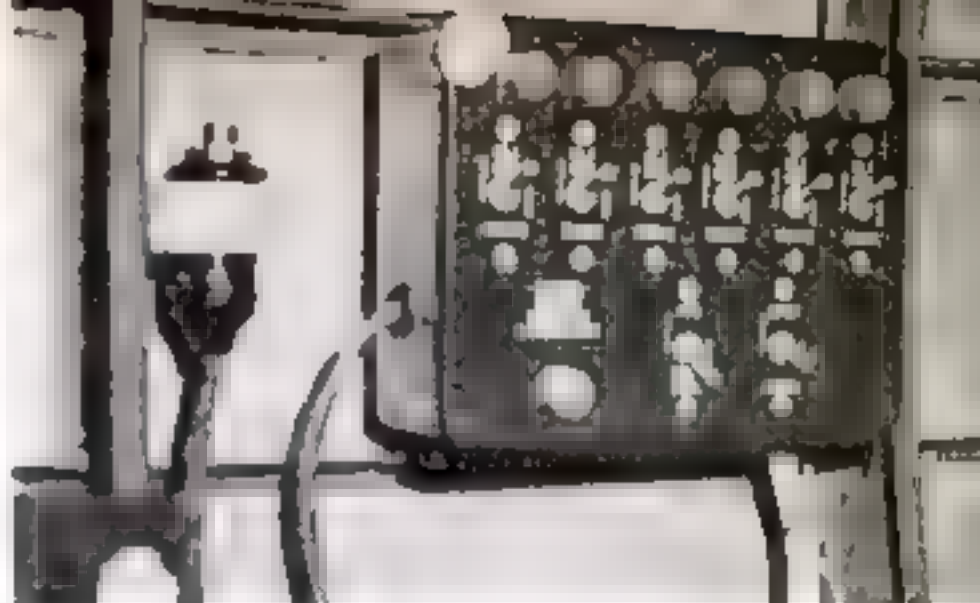
of their foes, as the record amply proves.

An airborne division is still a "weapon of opportunity." It cannot be used with maximum efficiency until a high degree of air superiority has been attained, the weather is okay, co-ordination with other forces has

been arranged, and important objectives have been chosen that can be taken quickly by lightly armed men. Hurling an airborne division directly at a mighty and mobile ground force now would be like sending high-school boys out to play football against a heavy, professional team on its home field. An airborne division cannot yet be reasonably expected to sustain itself in enemy territory for
(Continued on page 77)



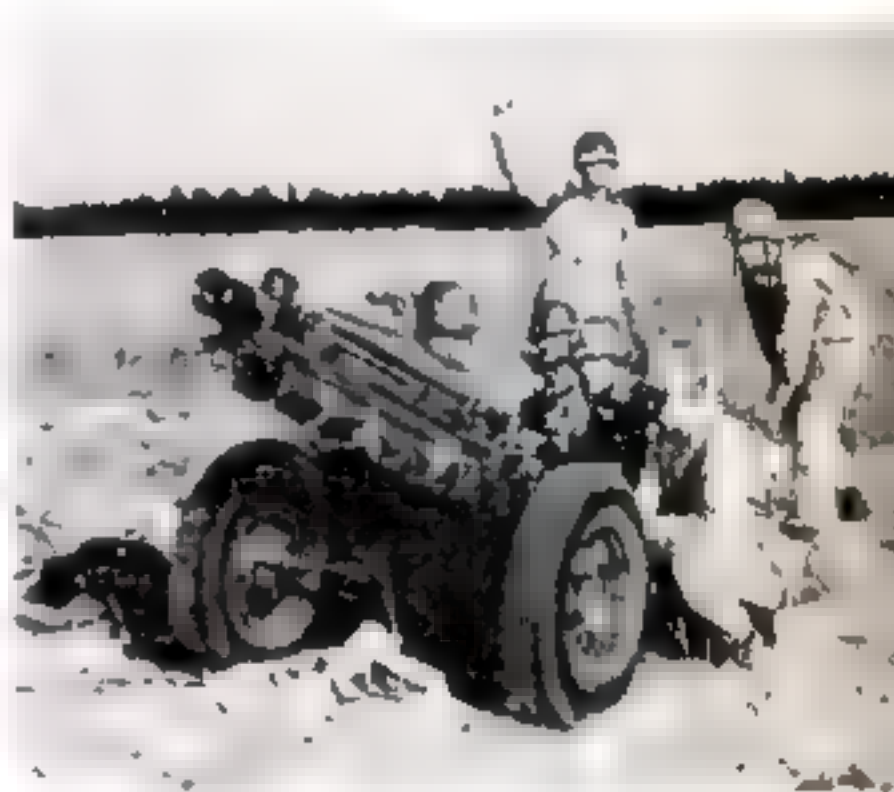
3 Here a bundle is being placed in its rack. There are six racks on the plane. The three remaining bundles are stacked at the door of the ship, ready to be thrown out just before the crew hits the silk



4 This is the control panel that releases the cargo 'chutes. Each switch releases a bomb clutch that lets a big bundle fall. The bundles are linked to keep them from hitting the ground more than 660 feet apart



8 Three of the paratroopers put harnesses on their shoulders and run ahead to drag the gun. One man sits on the barrel to hold it down, while the rest pull or push. With split-second teamwork, they rush the piece into position



9 Now the gun is being aimed and fired, delivering effective firepower in the enemy's rear. Howitzers like this were used with telling effect in Sicily and on the invasion front in Normandy

EVEN AN AMMUNITION CART COMES DOWN WITH THE 75



THIS is one of the boxes that tumble out of the sky with the 75-mm. paragon as shown in the pictures above. Now watch what comes out of it.

When the lid is removed (lower left), you find an axle and two wheels. Attached to the box, they turn it into a cart for hauling ammunition (below). The same box contains several rounds in long fiber cartons.

Additional ammunition is dropped separately, wrapped in long blanket rolls. When picked up, this is hauled in the cart to the gun position. For safety, fuses for the shells are carried down separately by the men.



GLIDER LANDS WITH 25-BED HOSPITAL

LANDING, men pile out. Complete hospital equipment is carried in 34 mountain-type packs like those seen at right. Personnel includes two surgeons, one anesthetist, and 33 enlisted technicians. Weight of the packs ranges from 35 to 85 pounds



AUTOCLAVE for sterilizing dressings, operating gowns, and gloves is shown at far right. Standard for all field hospitals, it is portable and operates like a pressure cooker. Ordinary Army gasoline is the fuel



SURGERY LAMP. An electric lantern and two jeep rear-view mirrors, quickly rigged above an operating table, give diffused light like that employed in regular hospitals, for night surgery



STERILIZER for instruments is standard field-hospital equipment. Here a technician is seen filling the gasoline burner. Instruments for all major operations are carried, plus replacements and auxiliary supplies

TENTS shelter workers and casualties. At left, below, is the shock tent; at right, the surgical tent. Ward tents for men who are receiving post-operative care may be pitched near by as required

SURGERY can be performed 20 minutes after the glider hits the ground. Sodium pentathol, given intravenously, is the most common anesthetic. Concentrated albumen from human blood may be carried instead of plasma



more than five days unless they receive some help.

But chances to use these forces arise constantly. They can cut communication and supply lines, delay the arrival of the enemy's reserves, create diversions and confusion in his rear, reinforce imperiled units of their own men, and seize and hold strategically important but lightly defended areas. Even when idle, an airborne division is useful. For its mere presence in a combat theater forces the foe to guard many points in his rear that he might otherwise neglect.

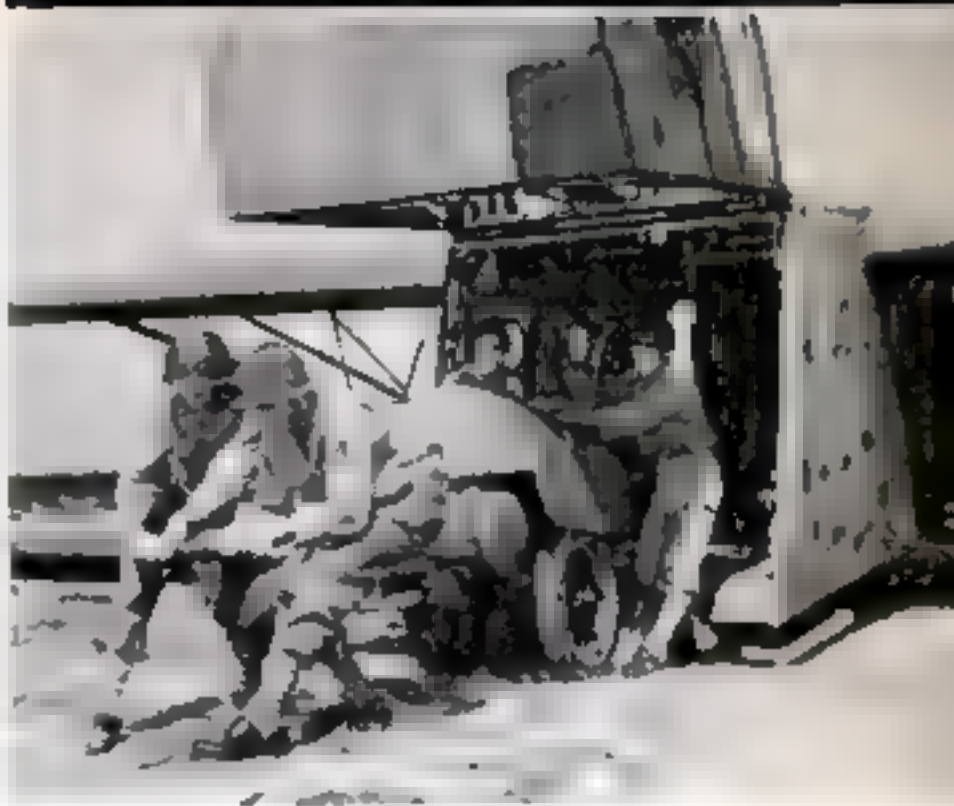
Suppose, for a minute, that you could see an airborne division land. In less time than it takes a crew of circus roustabouts to fill a vacant lot with tents and animals, a field would be filled with warriors and weapons. Brightly colored parachutes, popping out of low-flying planes like flags from a magician's hat, would briefly cover acres of sky. Fleets of boxcars beneath wings without motors would coast over tree-tops and land in rows like parked automobiles. Out of parachuted bundles, and out of the noses of gliders, would come cannon and ammunition wagons, jeeps, motorcycles, trucks, and nearly all the other paraphernalia of a modern mechanized army.

So much would happen so fast that you could see only a small fraction of this activity. A 75-mm. howitzer might be parachuted down, assembled, loaded, and fired in 8½ minutes. Almost simultaneously, the airborne engineers might be blowing up a bridge, laying a mine field, and pumping water through a purifier into a canvas tank. Meanwhile, the ordnance men might have set up a machine shop to repair damaged matériel, and the surgeons would have their portable hospital ready for operations on wounded men.

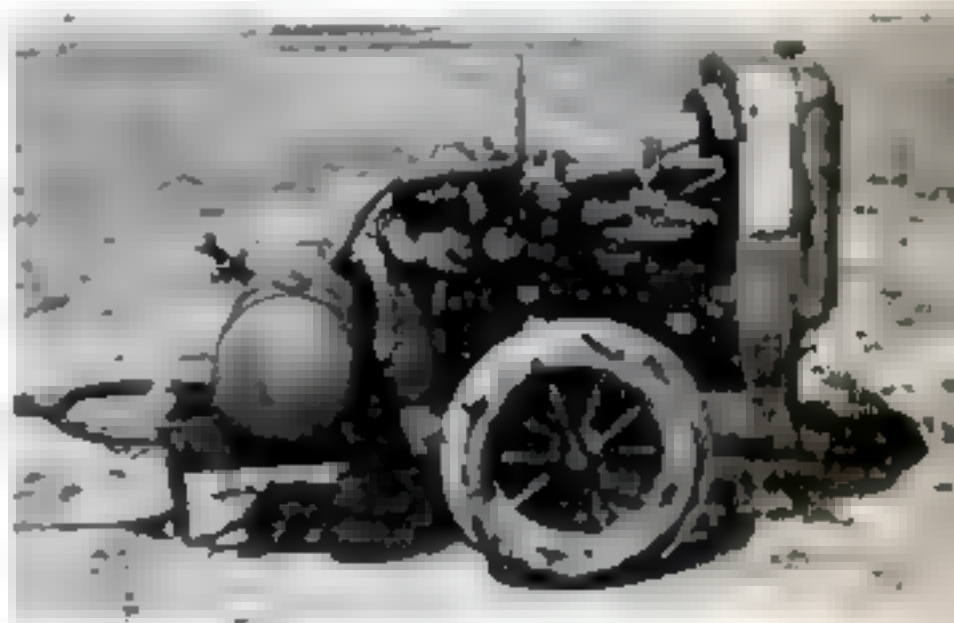
The exact portion of the enemy's rear to be jabbed and taken over by such a division might have been marked by pathfinders a few hours before the arrival of the main force. The pathfinders are small, select groups of paratroops who leap from high altitudes and delay opening their 'chutes until close to the ground to avoid detection. These men carry flares, smoke pots, and other equipment to enable the troop-carrier planes, coming in low in the dark of night with the main body of paratroops, to find the precise point designated in their orders as the DZ (drop zone).

Since a small unit surrounded by the enemy might be quickly destroyed, landings may be made simultaneously at several points and by both parachute and glider regiments. A 15-passenger glider can be landed silently in less space than you need to play football; even bigger gliders can slip into jungle clearings too small and rough for airplanes. And the minute an airborne division touches the ground, its men begin to function just like other highly trained and well-equipped infantrymen.

"A four-star general dignifies himself when he salutes them," *The New York Times* has said of our paratroops. They are this war's lightweight champs. They look like the tough little guys who sometimes play quarterback on big-time football teams. Never more than six feet tall, or weighing more than 184 pounds, these men are (Continued on page 222)



Out of a glider rolls the mobile, 2,200-pound power plant that speeds the work of the airborne engineers. It runs saws, drills, pumps. Tools may come in by glider or drop on 'chutes.

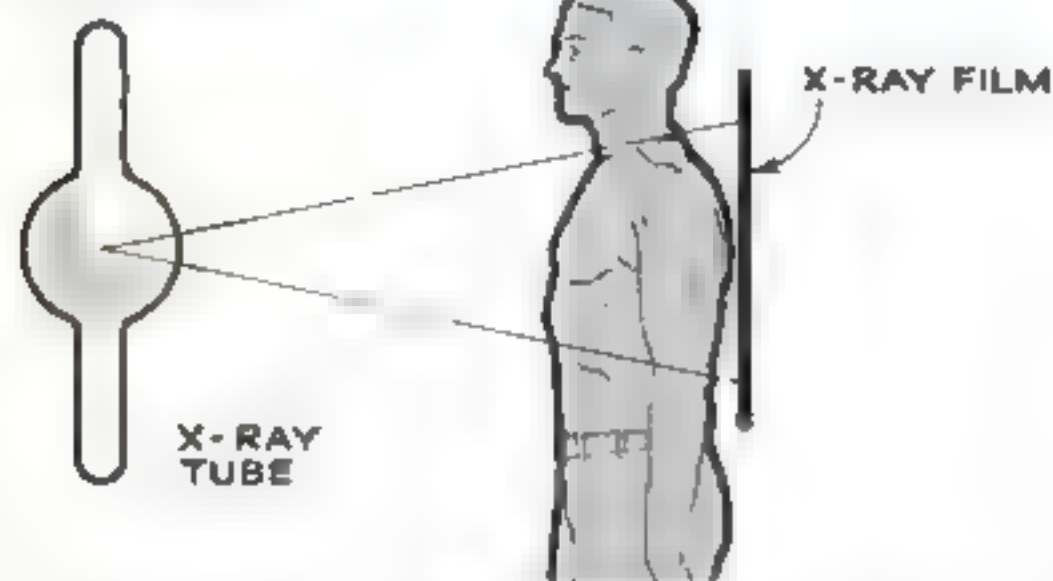


One man can operate the gasoline engine that develops the 105-pound air pressure. The unit is ready for action on its two-wheeled mount. Its tank holds enough fuel for long-time use.

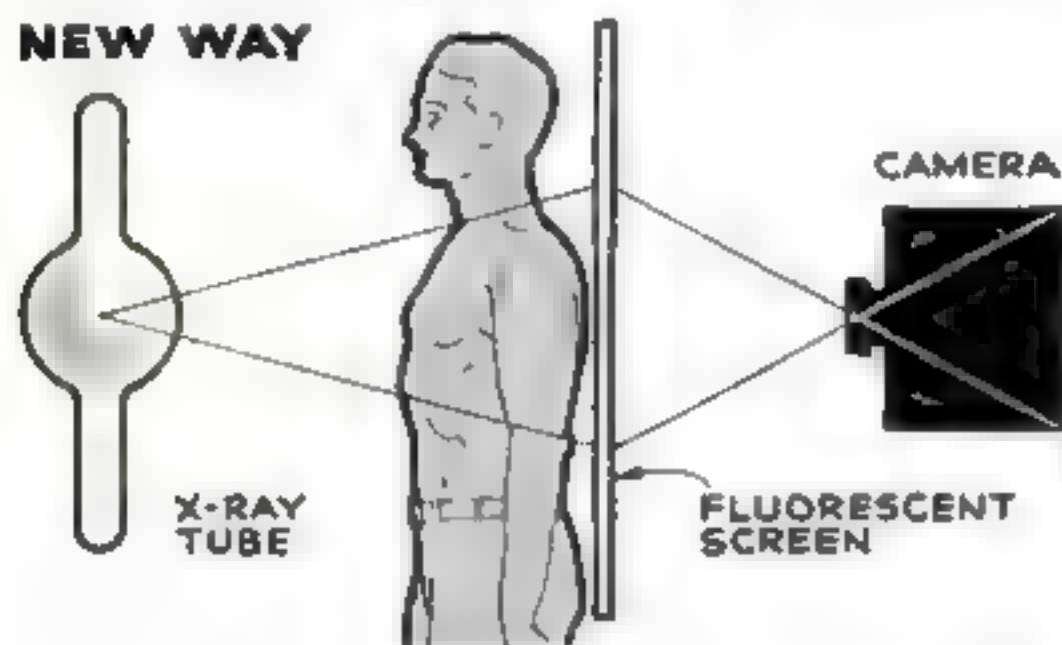


This powered band saw makes quick work of the erection of tank barriers in the enemy's rear. The compressor also runs a high-speed circular saw for cutting boards. Another use is for inflating rubber assault boats or bridge pontoons.

OLD WAY



NEW WAY



MEDICINE

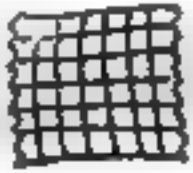
TOO MUCH X-RAY FILM was being used. So thought Lt. Col. Zolon T. Wirtshafter, chief of civilian medicine at the AAF laboratories, Wright Field, Dayton, Ohio, when he had to take X-ray pictures of 10,000 civilian employees' chests. Each film measured 14 by 17 inches, and the heavy equipment required three persons to operate it. Colonel Wirtshafter finally devised a substitute method that saved not only 90 percent of the film but time and labor in operating and processing. Instead of taking a direct X-ray shadowgraph on the large film, he places the subject against a fluorescent screen and directs the rays through him. On the other side of the screen is a camera that photographs the image on a 4-by-5 film. A roll 56 feet long, for 74 pictures, is exposed as fast as subjects step into position. Film cost is 1/15 that of usual X-ray film. The drawing at the left illustrates the new method



AGRICULTURE

GAS PERIL to apples in storage is minimized by the equivalent of a gas mask that has been developed by the Cornell University Agricultural Experiment Station. Ethylene gas is given off by the riper apples and speeds the spoiling of the fruit stored in the same bins with them. Like the gas masks used by humans, the apparatus filters the ethylene gas in the storage bin through activated charcoal with bromine added. The charcoal is placed in containers like that seen in the upper photograph at the right. These are set in sockets in the boxlike "gas-mask" apparatus (visible in the lower photograph) and the air is drawn through them by a circulator fan to remove the harmful gas.





FABRICS

HE'S NOT CRAZY, the gentleman shown at the right strolling nonchalantly through the rain. He's wearing a postwar suit made of one of the unshrinkable, crease-holding fabrics now being pioneered by textile chemists. Other radical new developments announced recently by the Monsanto Chemical Company include shineproof pants, runproof stockings, and double wear for both cotton and wool fabrics. All these developments, Monsanto reports, are based on new techniques of treating either the surface or the heart of fibers to produce the desired effect without changing the feel or texture of the material.



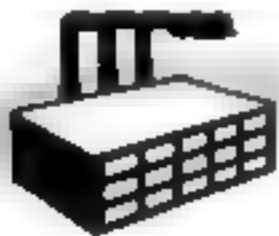
PHYSICS

NO PRIVACY FOR THE ATOM. For the further exploration of atomic mysteries, the Department of Terrestrial Magnetism of the Carnegie Institution at Washington recently put into operation a cyclotron, or atom smasher, that is one of the world's two largest. Generating atom-smashing projectiles of 15,000,000 electron volts energy, it measures with new accuracy the forces released by atomic disintegration.



CHEMISTRY

TWENTY-FIVE TRILLION vinyl resin particles are held in stable suspension in one cubic inch of the new colloidal Geon latex developed by the B. F. Goodrich Co. Resembling rubber latex in appearance, the new product is adaptable to a wide variety of applications such as coating paper and textiles, insulating wire, treating glass fibers and fabrics, manufacturing gloves and other products in which rubber latex has been used, treating leather for added wear and moisture protection, and making corrosion-resistant paints. The new latex can be brushed, sprayed, or dipped, and will allow the treated materials to "breathe."



INDUSTRY

FAKE RAINSTORM comes down from an adjustable water jar in the technical laboratory at the Du Pont Dye Works, Deepwater, N. J., for testing water-repellent fabric. Raising the jar increases force of the shower. Before and after the test, the operator weighs the blotting paper back of the sample to gauge penetration.

How the Navy Rolled Four AA Guns in One

THIRTY-TWO Jap torpedo bombers attacked the new U.S. battleship *South Dakota* on her first run into the South Pacific. A half hour later, the battleship's Bofors guns had blasted every enemy plane out of the sky.

First mounted singly, then in pairs, and now in sets of four, Americanized Bofors guns have distinguished themselves on many such occasions. **POPULAR SCIENCE MONTHLY** shows you now for the first time how four of these guns have been put on a single mount. (See sketch on next page.)

The 40-mm. Bofors was developed in Sweden and adopted by more than a dozen nations of Europe in the 1930's. It became a favorite because of its rate of fire, the ease with which overheated barrels could be replaced, and other characteristics. The British recommended it to the United States as a medium-range, general-utility gun to fill the gap between heavy antiaircraft artillery and pom-poms.

The Bofors takes its two-pound shells in clips of four, which are fed into the breech from the top. In this it differs from our 37-mm. antiaircraft gun, which uses clips of ten and feeds from the side of the breech. The Navy version of the Bofors is slightly different from the Army version. The guns shown in the drawing may be operated either electrically or manually. The mount

is not always shielded. The crew includes loaders, ammunition passers, a pointer, a trainer, and a talker. The flash hider, or muzzle blinker, prevents the flash from blinding the gunners. Tracer shells help them find the target.

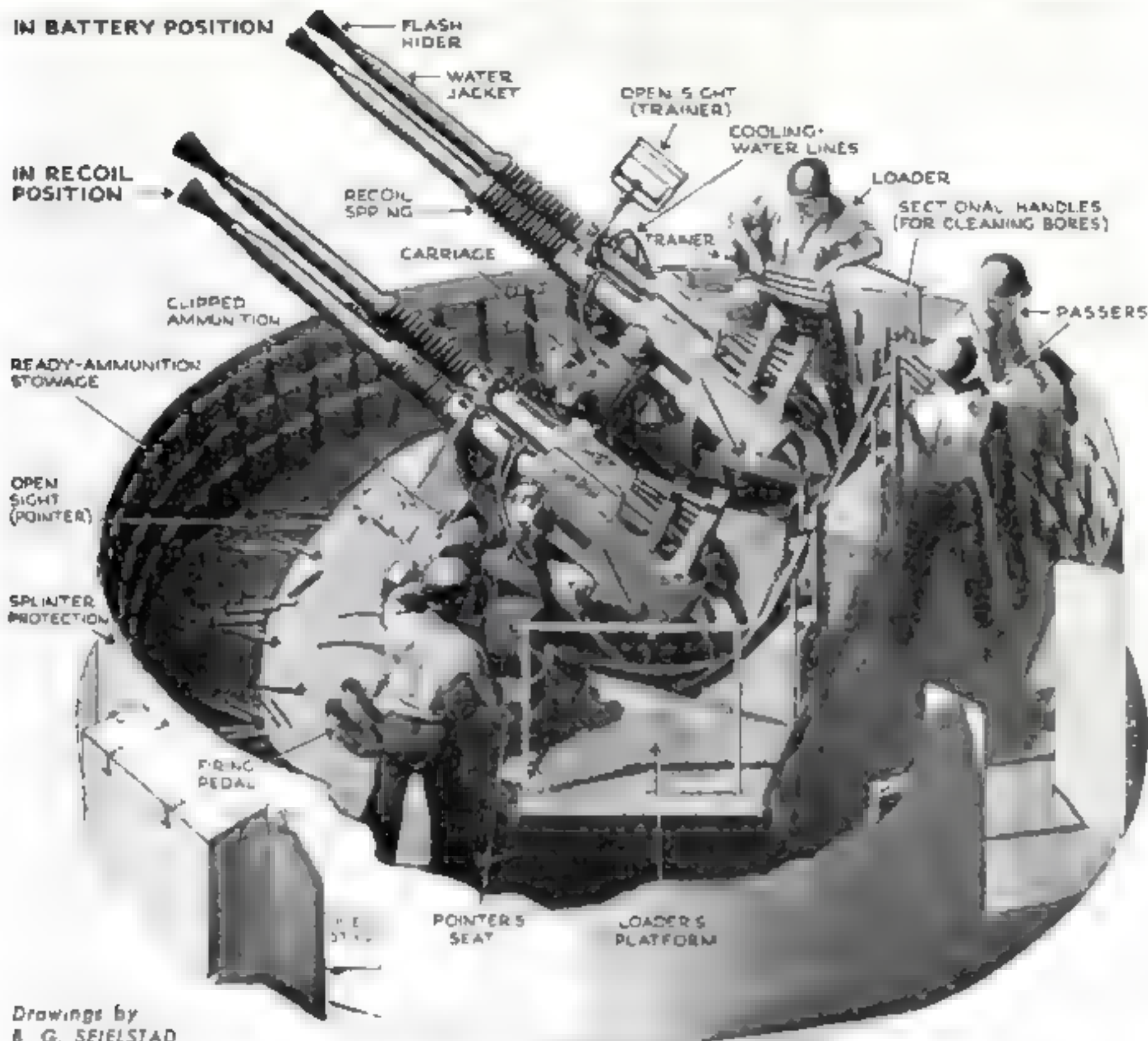
The original Bofors was a work of art, skillfully but slowly built and fitted together by hand. The American versions are assembly-line products, turned out 30 times as fast as such guns were ever made before. The plans with which American engineers began were in the metric system, measurements for hand-fitted parts were only approximate, and material specifications were based on European standards. Both dimensionally and metallurgically, the gun had to be completely re-engineered before it could be put into mass production.

Time, money, and materials were saved by substituting machine work for hand fitting; by using castings, forgings, and welding, and by many other innovations. The barrel was drilled with a two-hip rather than a single-hip drill. A new broaching cutter reduced the time required for rifle grooving from six hours to 45 minutes. American methods of assembling the gun, quickly devised and substituted for the filing-and-fitting work done in Europe, have cut the time required for this part of the work from 450 hours to less than 24.



ARMY VERSION of the Bofors, seen here set for action in New Guinea, is different in a few details from the type used by the Navy. It has done a swell job in defending our land forces from aerial attack. Characteristic of the Bofors, on land or sea, is the flaring flash hider on the muzzle. This keeps gunners from being blinded

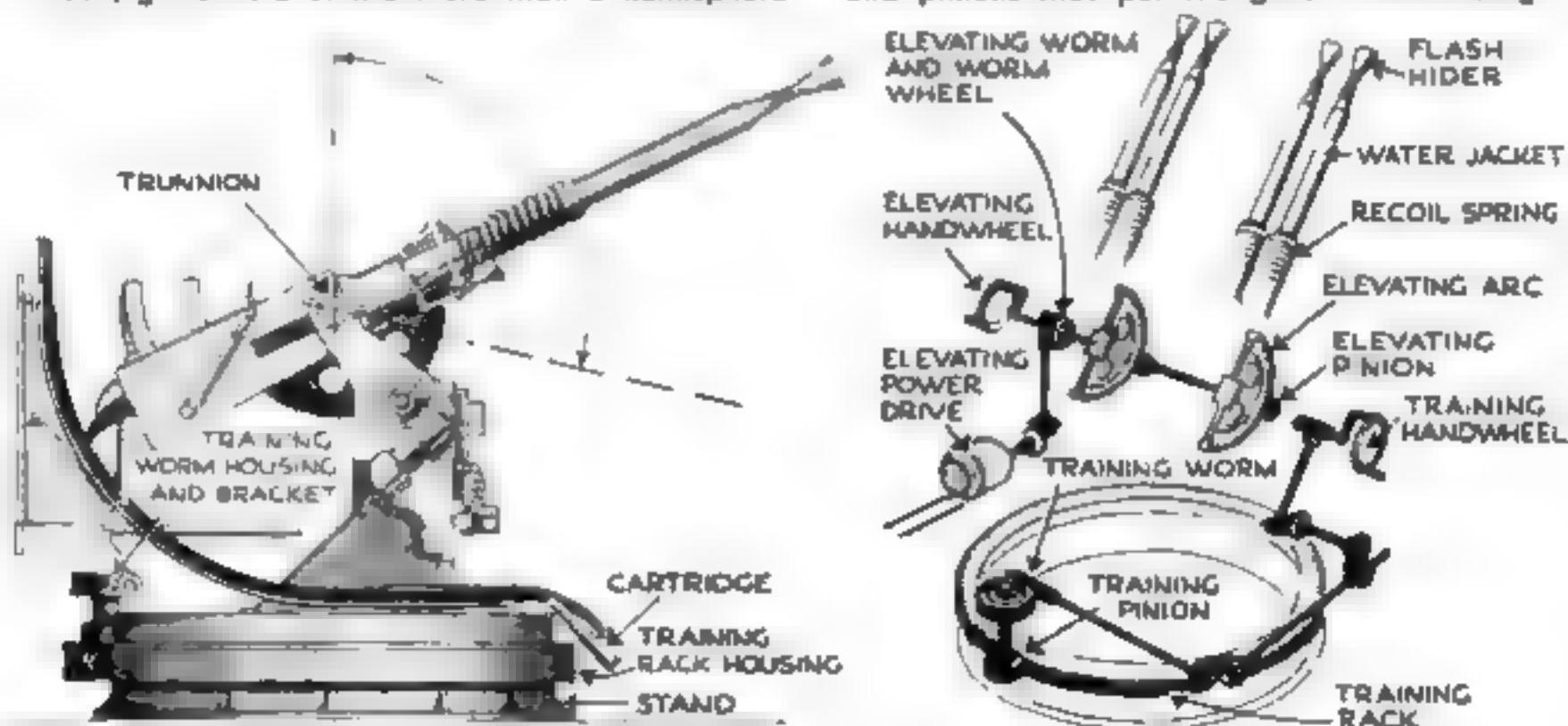
FOUR-BARRELED DEATH: THE QUADRUPLE BÖFORS MOUNT



THIS IS THE MECHANISM THAT AIMS THE GUNS

Elevation arc of more than 90 degrees, and traverse of 360, gives field of fire more than a hemisphere

The drawing below shows the systems of gears and pinions that put the guns on their target



THANKS TO A MAGIC BOX IN
THE CIRCLE, PITCHING CAN'T
SPOIL THIS TANK'S AIM



OWI Photo by Etlasse

Gunfire from this M-4 while in motion would be a hit-or-miss proposition without the gyro-stabilizer invented by Clinton R. Hanna and now in use on our tanks and those of our allies

Why Our Tanks Can Score Hits on the Run

By GOLD V. SANDERS

Drawings by STEWART ROUSE

ANYONE who has taken a ride in a tank knows it is just about the most efficient vehicle ever devised to shake the day-lights out of a man. The wildest Wild West bronco isn't in it with these bucking, pitching, heaving, unsprung monsters.

Consider, then, the problems involved in trying to hold a tank gun on a target while the tank itself lurches and jolts across a rough battlefield. Impossible, you would say—and so did everybody else, until Clinton R. Hanna tackled it. He was accustomed to having tough problems thrown in his lap down at the Westinghouse research laboratories in Pittsburgh, and he had a brilliant record of solving them. In his 21 years with Westinghouse he had devised

many ingenious controls for industrial machinery, electrical and mechanical. To stabilize a gun in a pitching tank did not strike Hanna as being impossible at all. He was sure from the start that it could be done.

Well, it was done, and today every one of our Army tanks, big and little, is carrying one of Hanna's ingenious gyrostabilizers. For some time it has been reported that our tank guns showed uncanny ability to hold the line of fire while advancing against the enemy in Africa, Sicily, and Italy. The War Department has now lifted the lid, being sure that the enemy knows all about it, so the contents of that little black box can be examined and explained.

Our tank gunners can now score almost as many hits while in motion as standing still. The stabilizer takes out 96 percent of





Westinghouse Photos

BULL'S-EYES! The test photos above show how the stabilizer holds the gun on a target in a run over rough ground. A camera clamped to the tank gun's barrel, as seen at the right, "shot" the target whenever the gunner pressed the trigger. The position of the horizontal cross hair in the successive pictures tells the whole story

the jolts. The Nazi blitzkrieg tactics were outmoded by it the day it went into action. In the past, it was common practice for half of a group of tanks to stop and fire, then advance while the other half stopped. Thus, only half of the tanks would be firing at one time, and while firing they were sitting ducks for the enemy's tanks, airplanes, and artillery.

The Germans found out about our gyro-stabilizer, to their sorrow, in the Mediterranean battles. In a radio broadcast, they announced that they had discovered its secret and admitted that they were copying it. How successful they have been in this remains to be seen. In the meanwhile, we are furnishing the stabilizers to the British and the Russians.

To Hanna, the tank-gun problem naturally called for use of the gyroscopic principle. He already had a gyroscopic instrument in use, one he had invented to maintain the tension in a sheet of steel between two sets of rollers. By governing the speed of electric motors, this instrument kept the sheet from buckling or becoming too tight. To him, this was much the same as keeping a tank gun at a selected elevation.

Westinghouse made the first development money available, and Hanna went to work. Not only did he conceive the entire apparatus, but he directed the building of all



the various elements that make its magical operation possible. Previously he had invented the silverstat, a clever and extremely accurate device for regulating voltage. This became an important part of the stabilizer—the nervous system that carries messages from the brain, which is the gyroscope. The magnetic valve control and the oil pumps, which furnish the muscle power, turned out to be the most difficult problem of all. These must have extremely quick and positive action to produce the pressure that raises or lowers the gun breech. As finally worked out, the pumps consist of three tiny gears, a very compact and neat-working gadget that does beautifully all that is required of

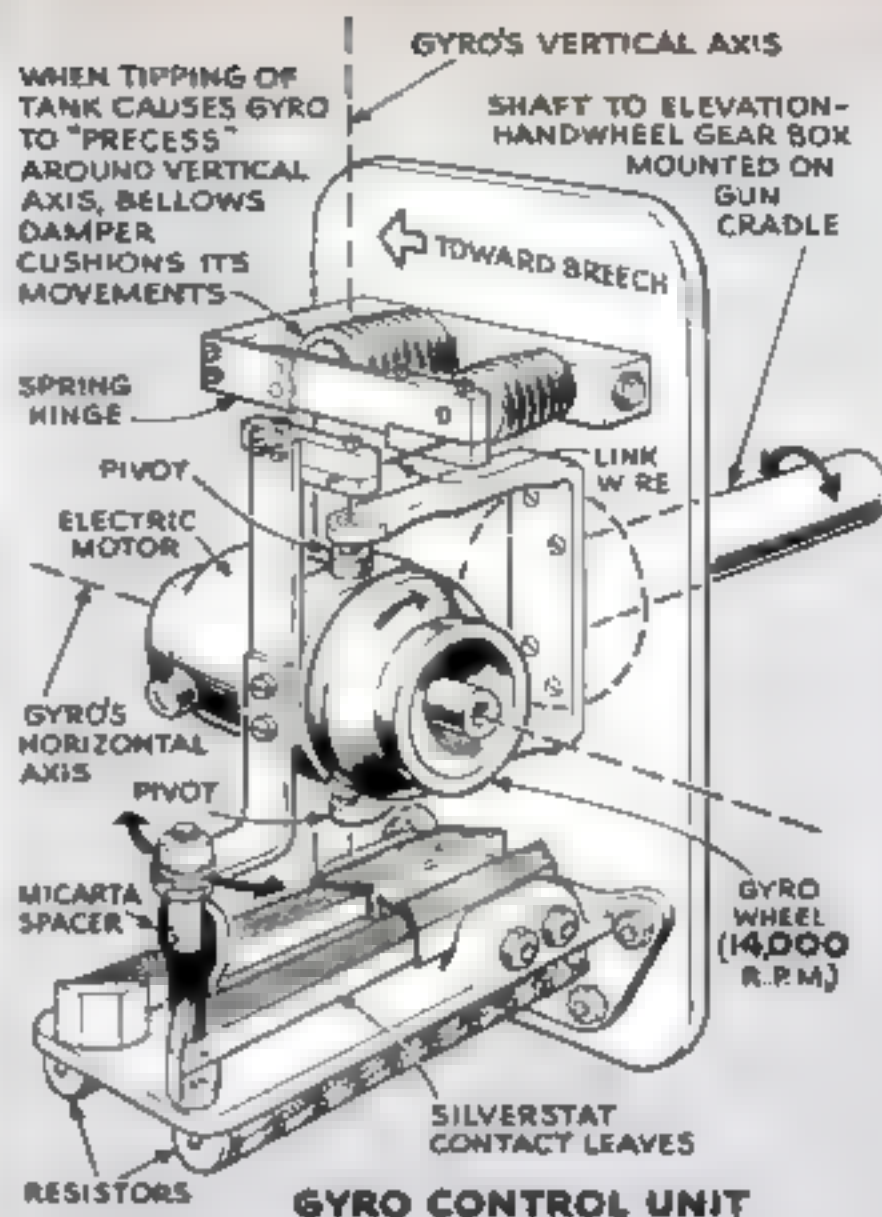


it. Oddly enough, only about 200 pounds' pressure is needed for what seems to be a big job. But Hanna explains that, because of its natural inertia, a gun wants to hold its position and only needs a little encouragement. What is really essential is quick action to prevent the gun breech from following the tank's pitching movements.

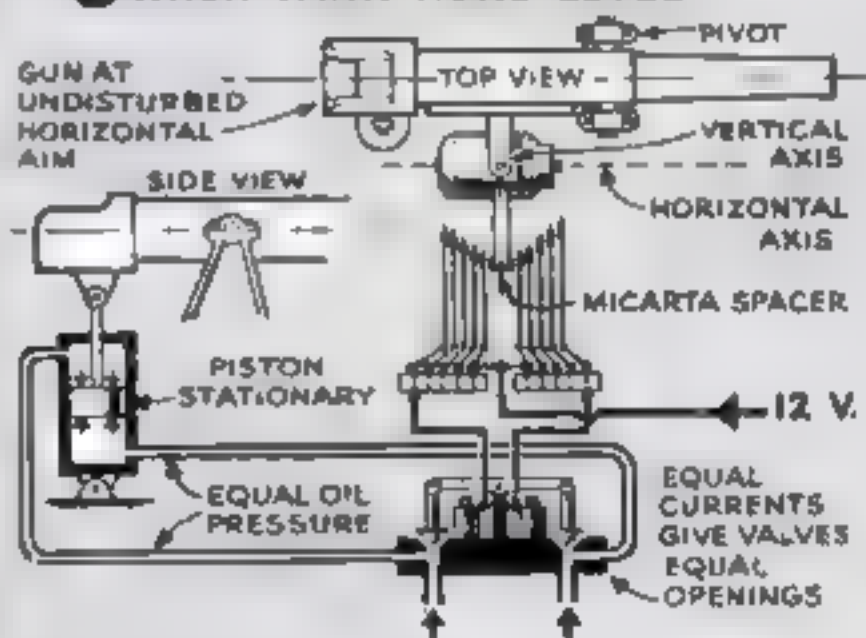
The first complete apparatus made by Hanna was tried out in the laboratory on a dummy gun made of an iron bar. Ordnance officers who saw it in action were astonished. It was next tried on a tank gun at the Aberdeen Proving Ground under battle conditions, and the Army men knew that they had something great. Things moved fast from that point onward. Westinghouse was given a big production contract, and a refrigerator plant, with 5,000 employees, was virtually turned over to the making of this device.

Hanna had started his experimental work early in 1940. By the middle of 1941 tanks were already being equipped with the revolutionary new device. Fortunately for the taxpayers, this marvelous instrument costs less than \$1,000. Its weight is negligible, but it manages big guns as well as small ones, or even better, Hanna says. That is where inertia comes in again.

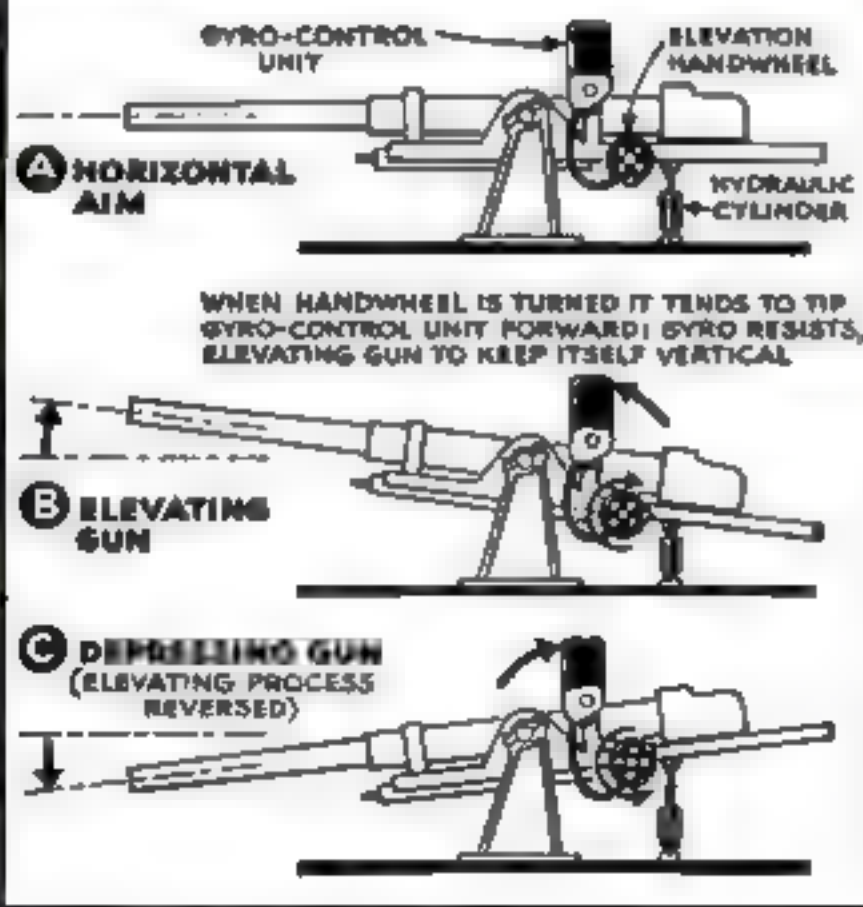
To see a tank gun under the control of one of these gyrostabilizers is an amazing experience. Stand in the turret and watch the muzzle of the gun as the tank bumps along, and you cannot detect any vertical movement at all. Then sit in the gunner's seat, and the back end of the gun seems to whip up and down beside you with terrific



▲ WHEN TANK RUNS LEVEL—

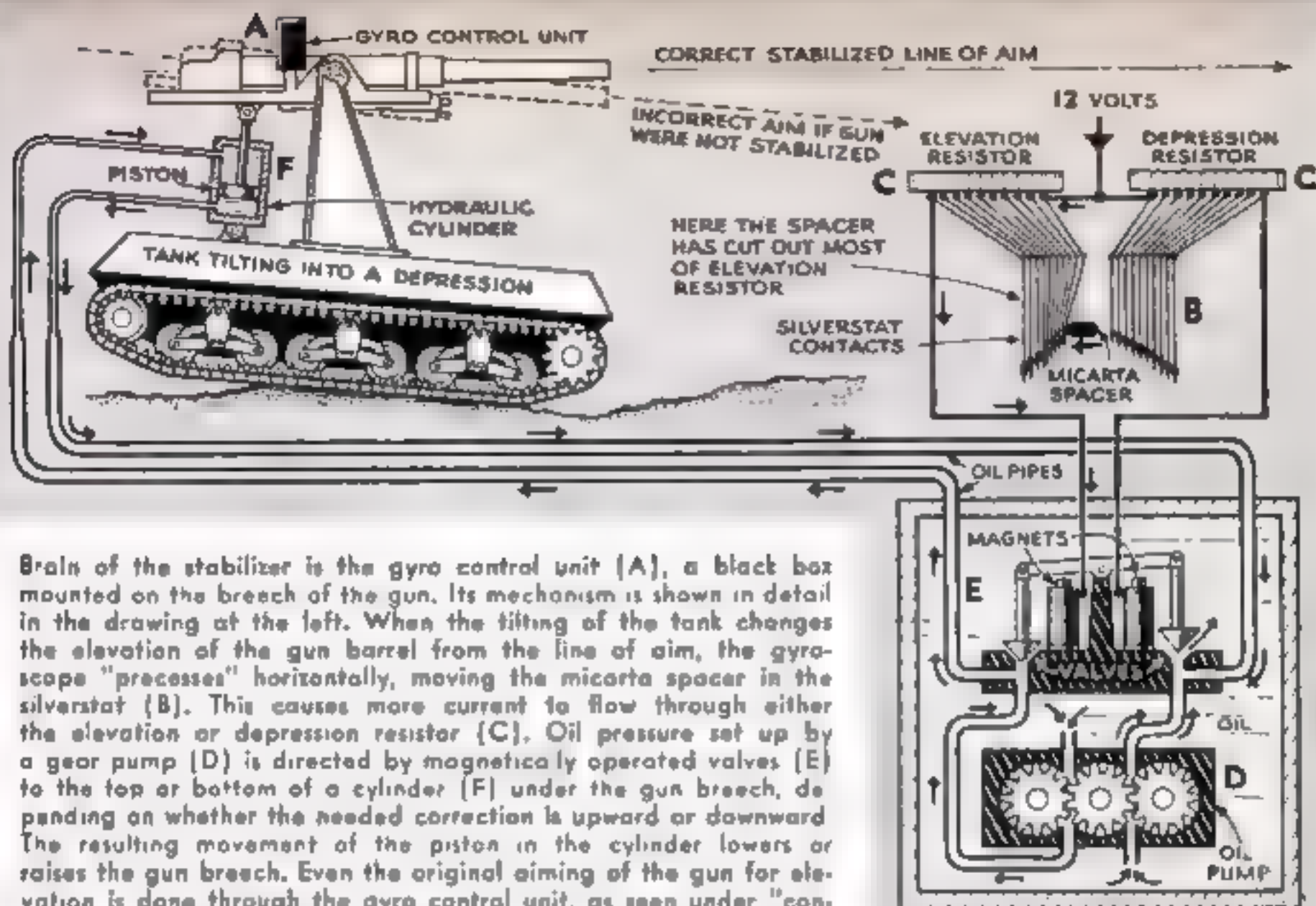


CONTROLLING ELEVATION

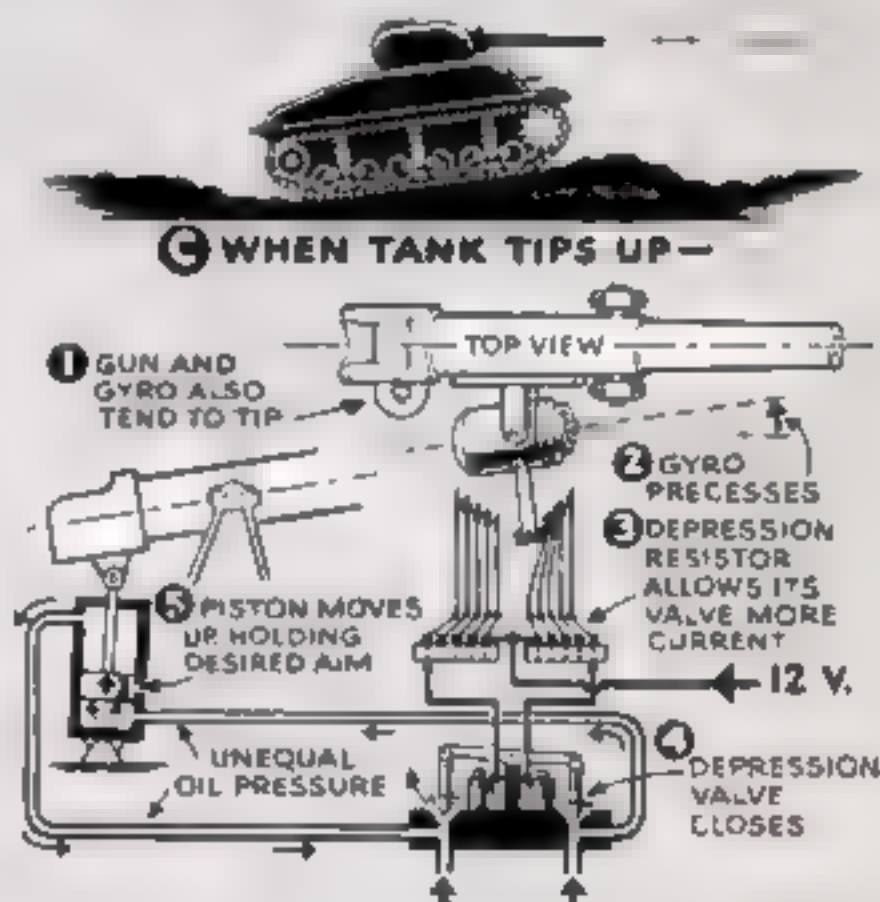
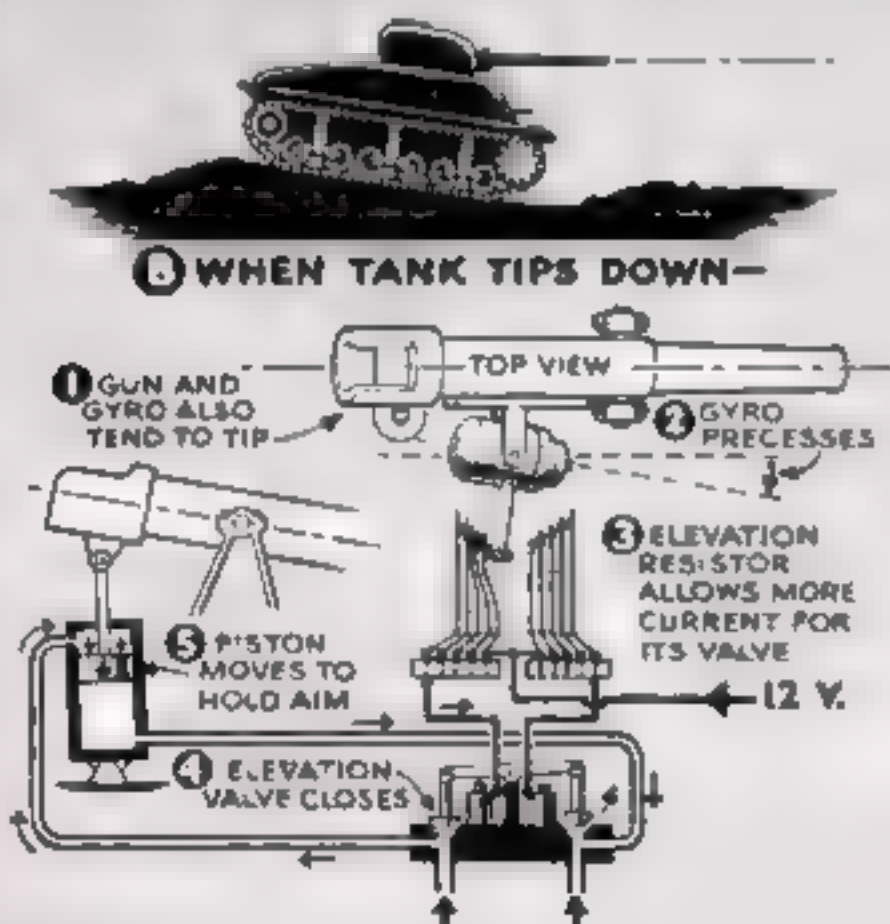


speed and force. Actually, the breech end is not moving at all; you are moving up and down with the tank.

It is only the up-and-down movement of the gun that is controlled by the stabilizer; horizontal control is still in the hands of the gunner, but this is the easiest part of tank gunnery. Good gunners are just as important as ever. The stabilizer is not an aiming device. What it does is to hold the



Brain of the stabilizer is the gyro control unit (A), a black box mounted on the breech of the gun. Its mechanism is shown in detail in the drawing at the left. When the tilting of the tank changes the elevation of the gun barrel from the line of aim, the gyroscope "precesses" horizontally, moving the micarta spacer in the silverstat (B). This causes more current to flow through either the elevation or depression resistor (C). Oil pressure set up by a gear pump (D) is directed by magnetically operated valves (E) to the top or bottom of a cylinder (F) under the gun breech, depending on whether the needed correction is upward or downward. The resulting movement of the piston in the cylinder lowers or raises the gun breech. Even the original aiming of the gun for elevation is done through the gyro control unit, as seen under "controlling elevation." Drawings below show the stabilizer in action



gun accurately to the elevation selected by the man who manipulates the elevating wheel.

Clinton R. Hanna was given a Presidential citation in 1942 for his invention of this effective war weapon (P.S.M., Oct. '43, p. 74). At that time it was held in such secrecy that his citation did not even vaguely describe what it was he had invented. Now that its real merit is known, it is plain

that this modest, soft-spoken research engineer, at the age of 44, has given his nation a contribution that has saved and will continue to save countless American lives.

Nor will its benefits cease when the war is won. Hanna has ideas about applying the principle to automobiles and railroad cars, and is now confident that he will be able to give us a smoother ride in our postwar cars than we have ever known.



Official U. S. Navy photograph

Like other modern American warships, this new U. S. destroyer gets its high speed from the "hottest" marine engines afloat—turbines gulping steam at hitherto unheard-of temperature and pressure. In ships of all sizes, these super power plants give the combination of speed and firepower that wins

How Hotter Steam Gives Our Navy Supremacy in Speed

By **LEONARD ENGEL**

Drawings by **STEWART ROUSE**

TWENTY-FIVE years ago, warships were either well armed and armored but slow, or fast and poorly protected. A battleship had 10 big guns, 12 inches of side armor, and a speed of 22 knots. A battle cruiser, eight knots faster, carried nine-inch plate and only six or perhaps eight guns of large caliber.

The men-of-war we are sending against the Axis, however, have big rifles and heavy armor, and their speed, too. Our *North Carolina* class battleships, with nine 16-inch guns and 16 inches of armor, are capable of over 27 knots. Our 45,000-ton *Iowas*, similar in main armament, are even better protected and are reported to be five or more knots faster—the fastest capital ships afloat.

This advance in performance is due chiefly to new boilers and turbines that harness the enormous energy of steam at extreme temperatures and pressures—steam so hot

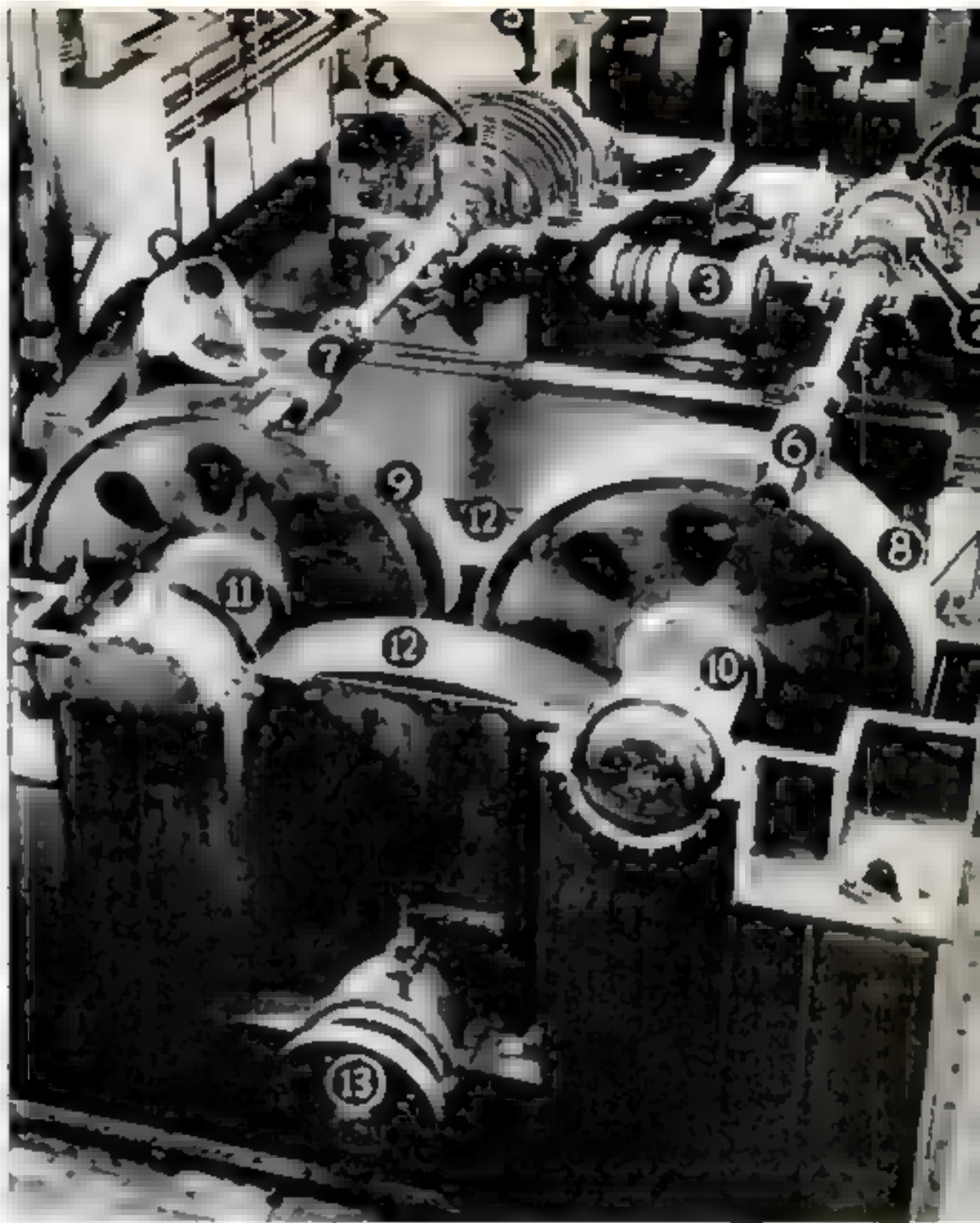
that transmission pipes glow red inside their heavy asbestos insulating jackets and safety pipes have to be mounted on rollers to allow for several inches of expansion. A pressure of 800 pounds per square inch and a temperature of 850 degrees F. are standard on the destroyers, cruisers, carriers, and battleships we have built since 1938. Some of our latest vessels probably employ even greater temperatures and pressures.

The 600-pound, 850-degree propelling plant consumes only 60 percent as much fuel per horsepower-hour as any type of ship engine used in World War I, when navies fought on 250 pounds and 400 degrees. Thanks to other improvements, especially in the gears linking turbines and propeller shafts, it is also lighter and more compact. As a result, double or even triple the horsepower can be packed into the same hull space; or, if the power is kept the same, armament, plating, and operating range can be greatly increased. Hence our big battlewagons that speed along like cruisers, and our cruisers that slug like heavyweights.

A look at the *North Carolina's* engines,

A VICTORY SHIP'S POWER PLANT—AND HOW IT OPERATES

To set the gears of this 125-ton, 8,500-hp. turbine plant in motion, water in the boiler is converted to superheated steam of 740 degrees F., which is hot enough to turn the transmission pipes a dull red. Entering the high-pressure turbine (1), the steam, with a pressure of 440 pounds, slams up against the 2,000 stainless-steel blades of the turbine, imparts a 4,250-hp. spin to the rotor, and races on to the end of the turbine (2), all in 1/30 of a second. From here it passes through a connecting pipe (3) to the low-pressure turbine (4) where it arrives with only 260 degrees and 30 pounds of its original heat and pressure. Even this, however, is enough to enable the longer-bladed, low-pressure turbine to extract another 4,250 horsepower. By the time the steam leaves this turbine and is sucked into a condenser (under turbines, 5), it is too cool to cook an egg. At full power, the first turbine turns at 5,300 r.p.m., the second at 4,400. Pinions (6, 7) turn reduction gears (8, 9) whose pinions (10, 11) turn the big "bull" gear (12). To this gear's shaft is fixed the ship's "prop"



Westinghouse

which can turn up more than 115,000 horsepower, shows what the new propelling machinery is like. The plant generates steam of 600 pounds and 850 degrees in two stages. In the first, extra-strong water-tube boilers convert water into steam, bringing it to the desired pressure and to what is known as the "saturation temperature"—the boiling point

of water at any particular pressure (488 degrees for 600 pounds). The "saturated" steam then passes to special superheaters where it is brought to operating heat.

The powerful steam, exploding from the superheaters at 150 feet a second, drives the *North Carolina's* four sets of turbines, each of which turns a *(Continued on page 90)*

WARSHIPS HAVE OTHER POWER NEEDS BESIDES PROPULSION

CARRIER ELEVATORS. Almost as important as their speed is the swiftness with which these ships can raise their planes to the deck or lower them to their hangars. Official U. S. Navy Photograph



ANTIAIRCRAFT GUNS bristle on our warships like porcupine quills. To keep them trained on scores of enemy planes calls for a lot of power

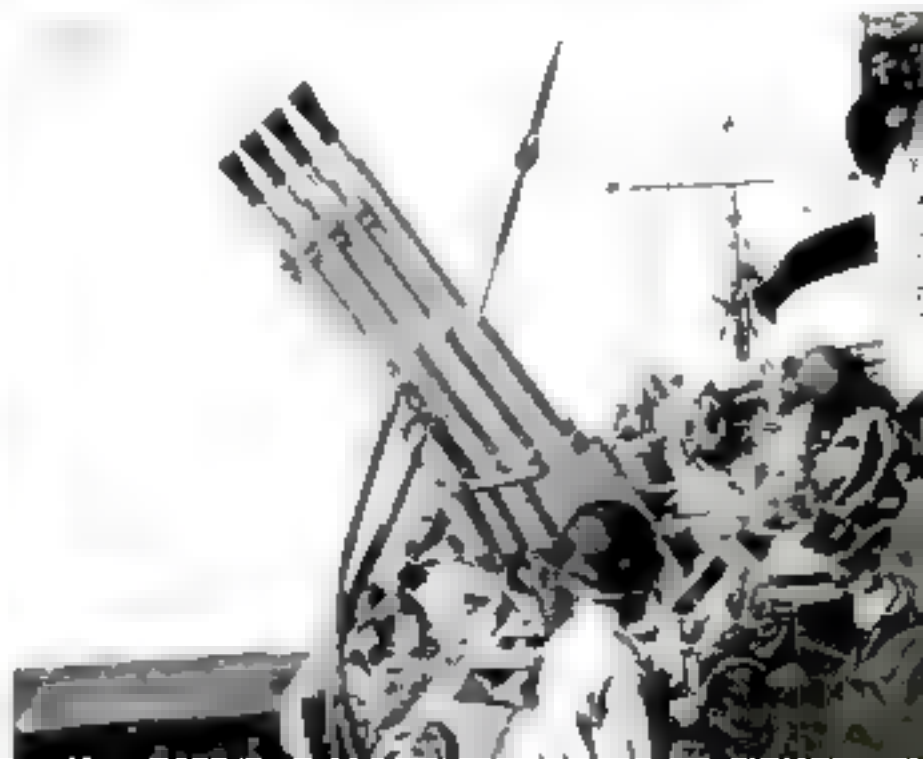
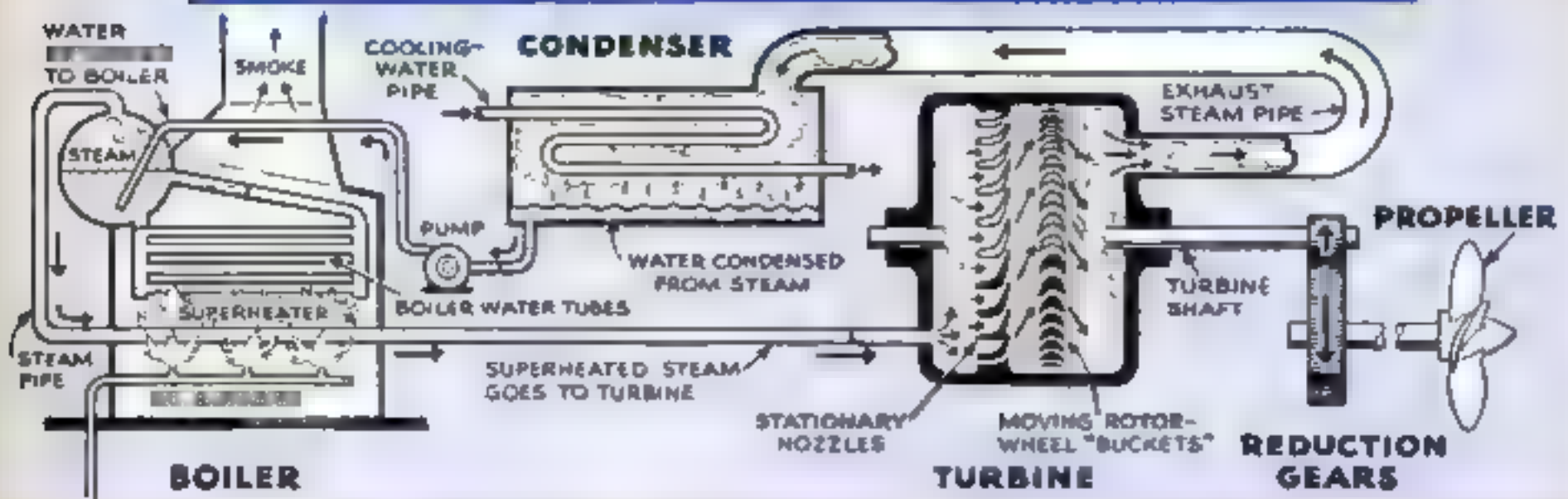
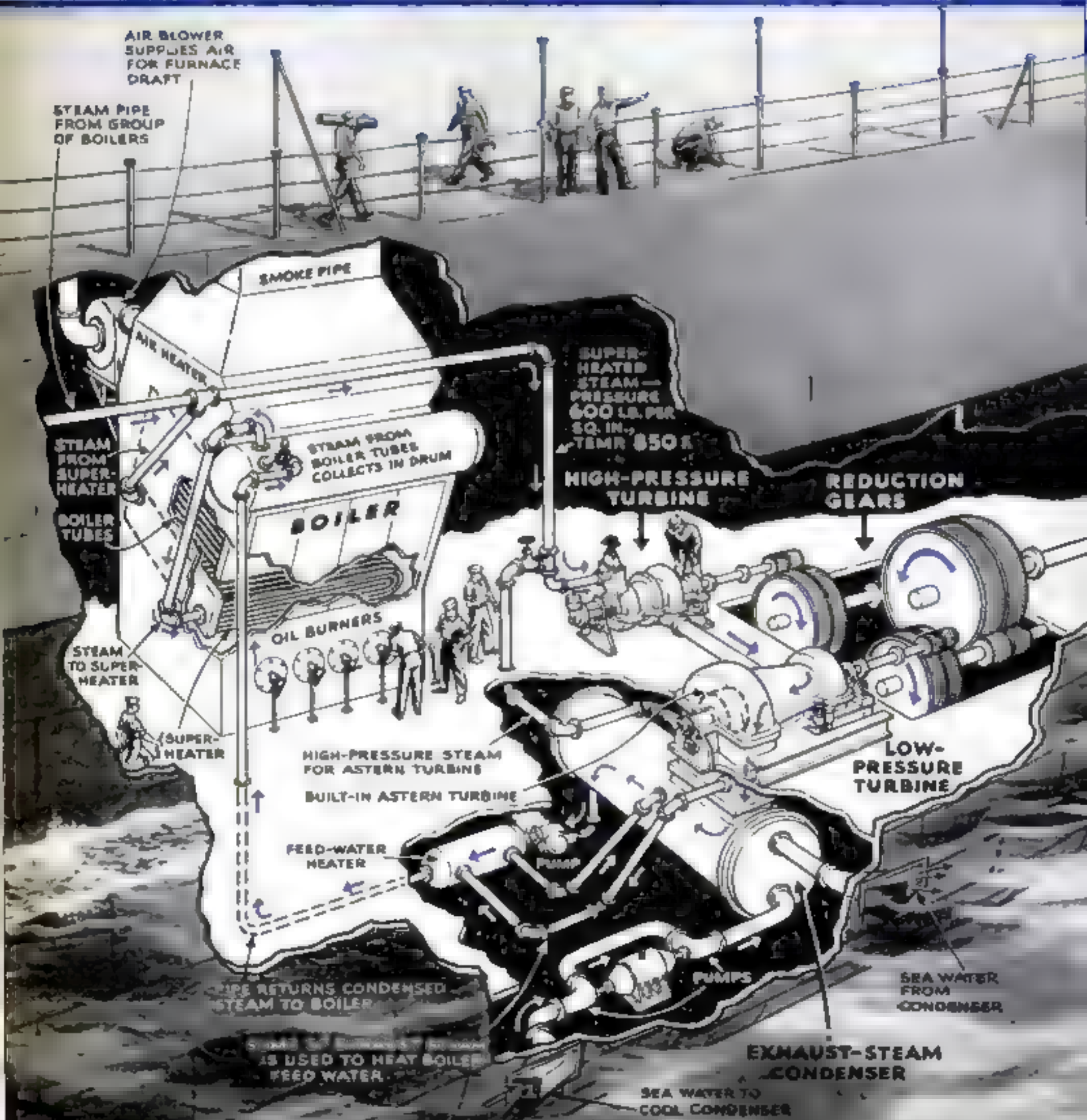


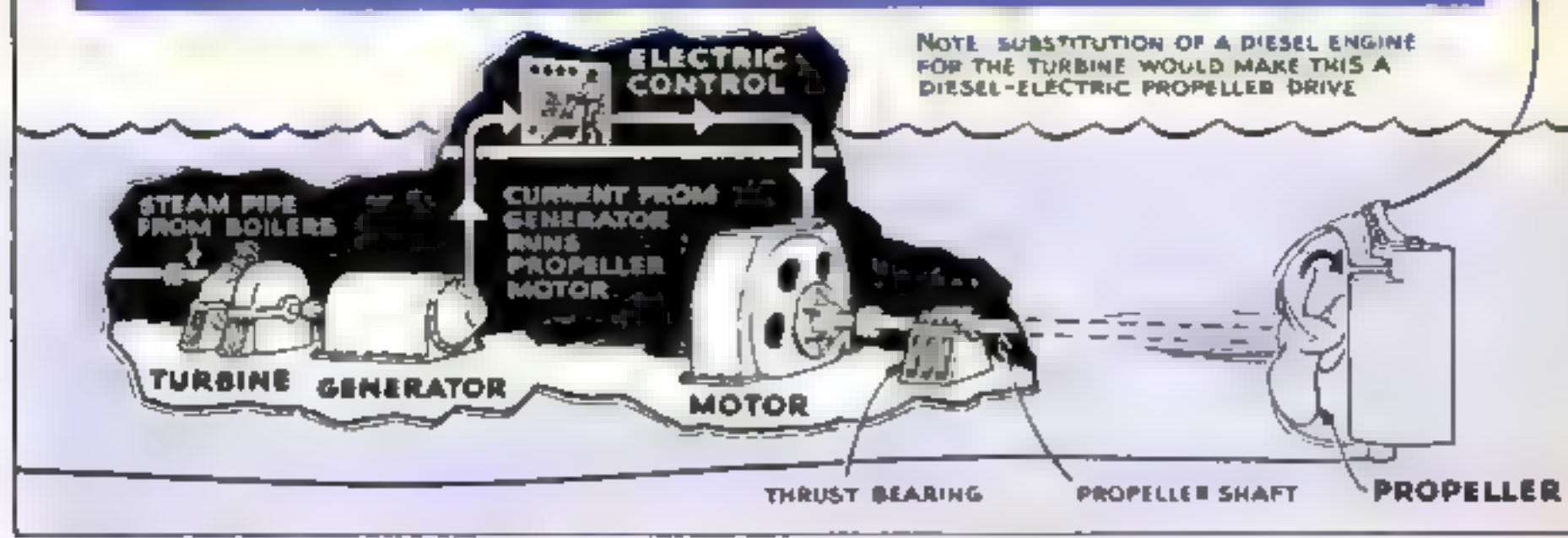
DIAGRAM OF GEARED-TURBINE PROPELLER DRIVE



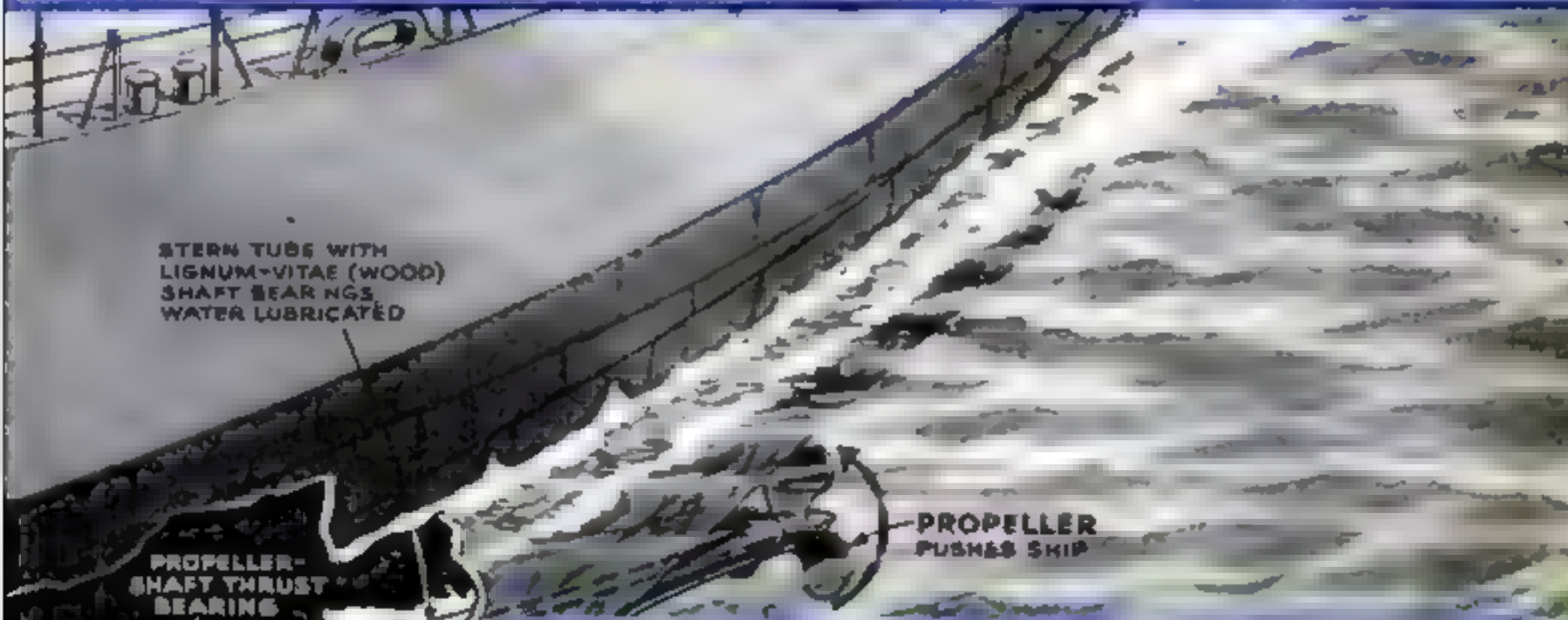
HOW CROSS-COMPOUND GEARED TURBINE



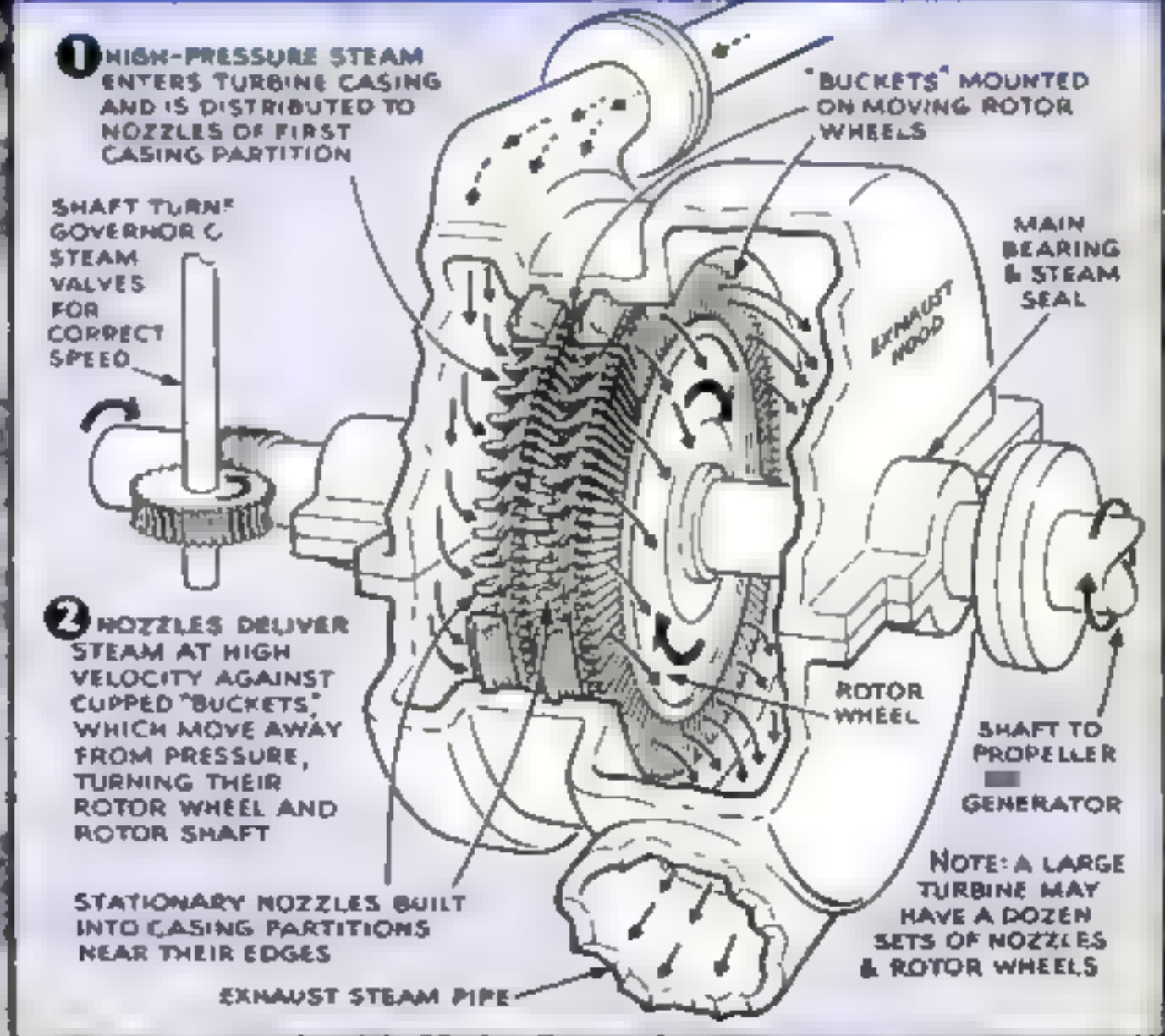
CUT-AWAY VIEW OF TURBO-ELECTRIC PROPELLER DRIVE

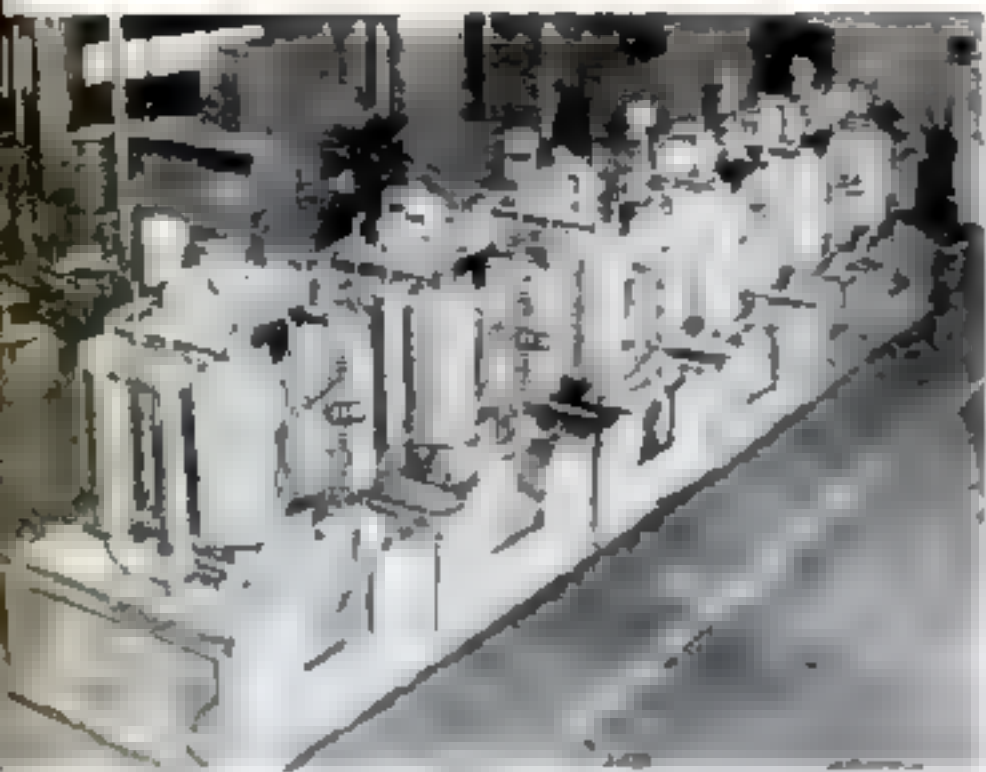


DRIVES ONE OF A BATTLESHIP'S PROPELLERS

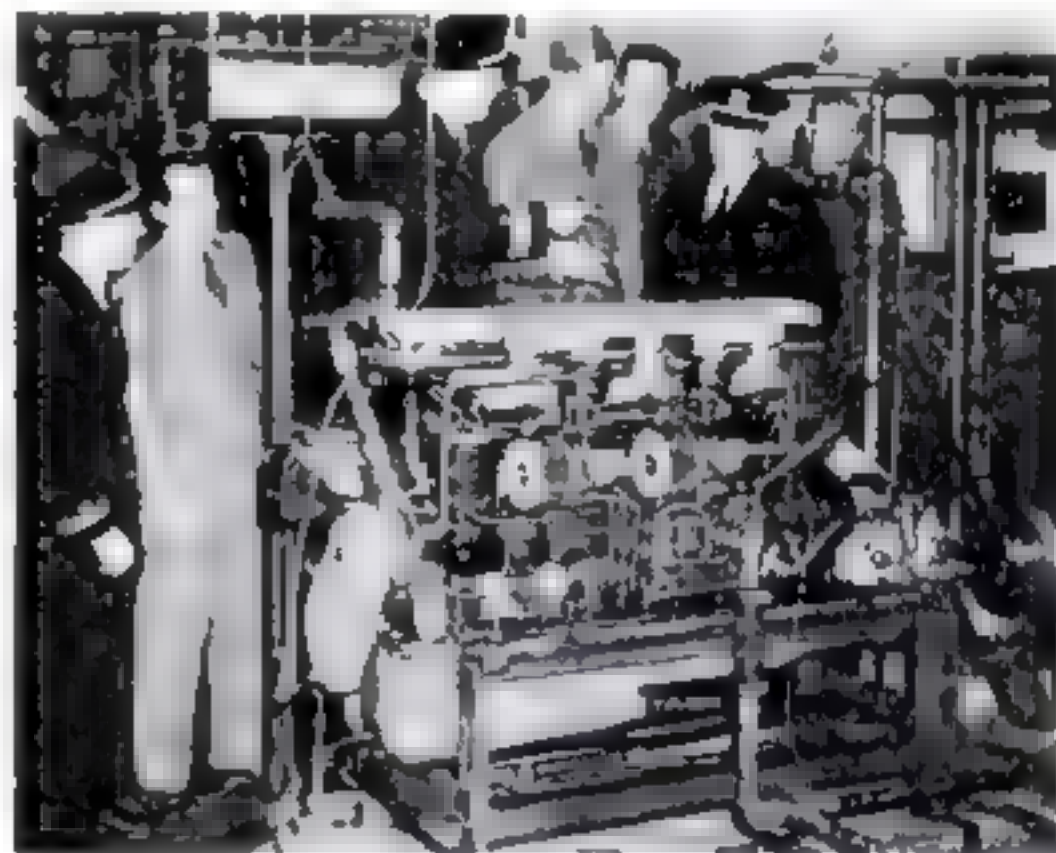


INTERNAL PARTS OF A STEAM TURBINE





"PANCAKE" DIESEL engines, such as those shown at the left, are now driving many of the Navy's submarine chasers. Produced by the Electromotive Division of General Motors, these huge, powerful engines are reported to have materially increased the cruising range, speed, and maneuverability of our sub hunters. For powering its newest submarine tenders, the Navy is using eight 1,600-hp. Diesels, four of which drive the ship, the other four supplying auxiliary power



GAS ENGINE. Known as the "Invader" and manufactured by the Hudson Motor Car Company, this giant motor is being used to power the LCVP (landing craft, vehicle, personnel) barges, rescue boats, and picket boats that our troops are using to storm enemy shores. It is shown here being inspected by company officials and representatives of the Navy. Putting the engine into production, which required 4,600 special tools and the conversion of 700 machines, was one of our fastest wartime jobs



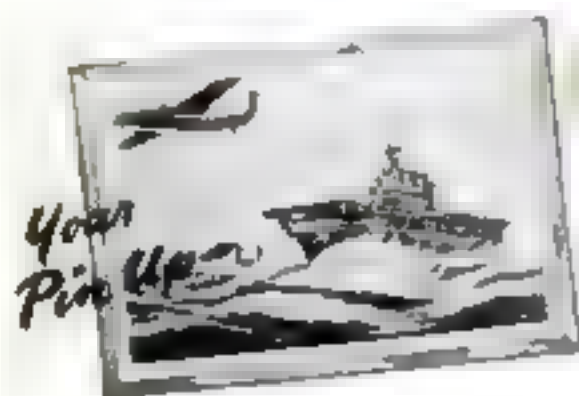
General Electric

GAS TURBINE. Rear Admiral H. L. Vickery and two officials of General Electric study a model of a gas turbine designed for installation on our ships. In place of steam, this type of engine employs expanding gas to turn its turbine blades. The model is for a 3,000-hp. unit

propeller. Although each turbine set delivers two to four times the horsepower, it is comparable in size to the several types on our older battleships. Faster rotation enables the *North Carolina's* turbines to achieve greater output without a corresponding increase in size.

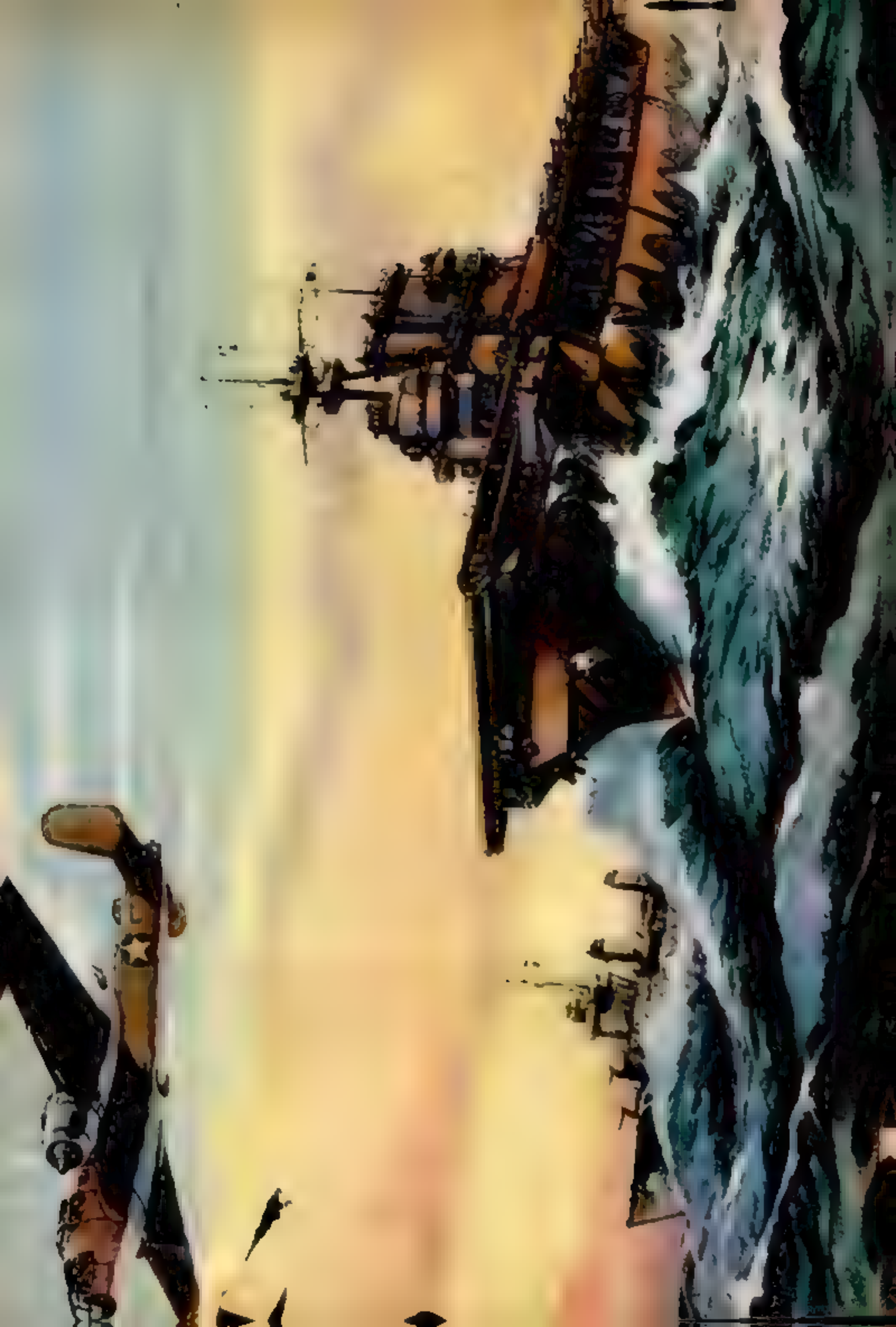
A generation ago, warship turbines were limited to comparatively low and inefficient speeds by certain electrical considerations, when a turboelectric drive was used, and by the mechanical limitations of the gearing then available. The gearing was of the

single-reduction type and could not bridge the gap between high turbine speed and the low speed that water forces on propellers. A single gear that could do so would have involved size and tooth pressures impossible for gearmakers even today. At that time, however, two-step reduction gearing was being introduced by designers anxious to put turbines on slow freighters. The *North Carolina* has newly developed double-reduction gears that not only transmit unprecedented power with only two-percent friction loss but also (Continued on page 242)



A FAMOUS FLAT-TOP... THE U.S.S. HORNET

Typical of the exploits made possible by America's world-beating marine power plants was the part played by the aircraft carrier *Hornet* in the first air raid on Japan. In this month's pin-up, Frederick Hoertz has pictured the historic moment on April 18, 1942, when Brig. Gen. James H. Doolittle led his squadron of North American Mitchell B-25's off the rolling, pitching deck of the floating "Shangri-La." In her brief career of one year and six days, this great flat-top also helped thrash the Nips at Midway. Crippled in the Battle of Santa Cruz Islands, she was sunk to save her from the foe





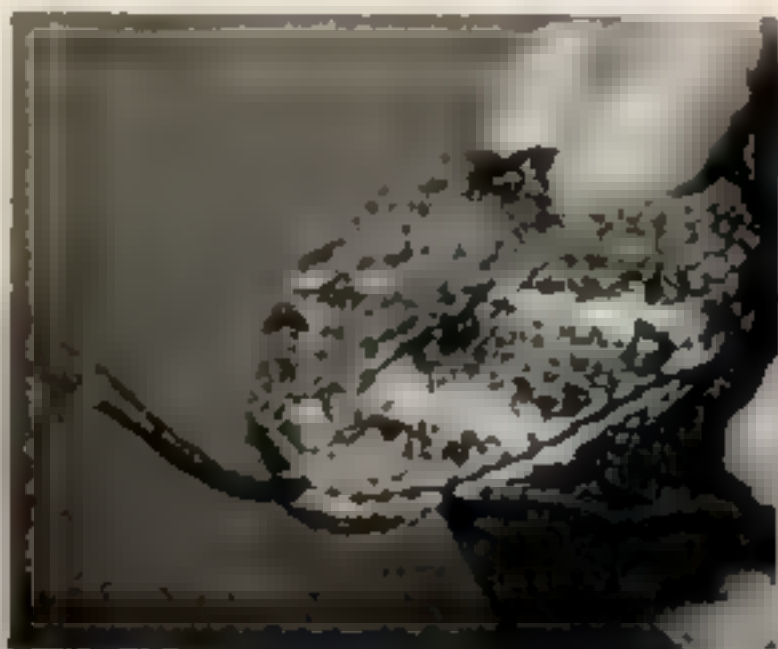
CAN WE MEASURE THE RATTLESNAKE'S

He isn't fooling! Coiled and ready to strike, this Totonacan rattlesnake of Mexico is a good example of America's most dreaded family of poisonous reptiles. Note the rattle. It isn't true that the number of rings in the rattle indicates the snake's age.

THE rattlesnake is peculiar to the New World. In his many varieties he is the most feared of North America's four kinds of poisonous snakes, largely because nature has distributed him generously. He is found in most parts of the United States and as far south as Brazil, but he is most numerous in the American Southwest and in Mexico. It is only in warm weather that he may be encountered underfoot. Ordinary caution is insurance against snake bite. A rattler will slither away noiselessly unless

Photos from "Fauna" a Publication of the Zoological Society of Philadelphia

he is cornered. A sharp eye and ear will spot his proximity. The track of the diamondback or timber rattler is almost straight when he is traveling in leisurely fashion. And his buzz, which does not necessarily mean attack but often only annoyance or excitement, is unmistakable.



The evil-looking head of a western diamondback rattler, showing the forked tongue, which flicks in and out at an almost unbelievable speed.

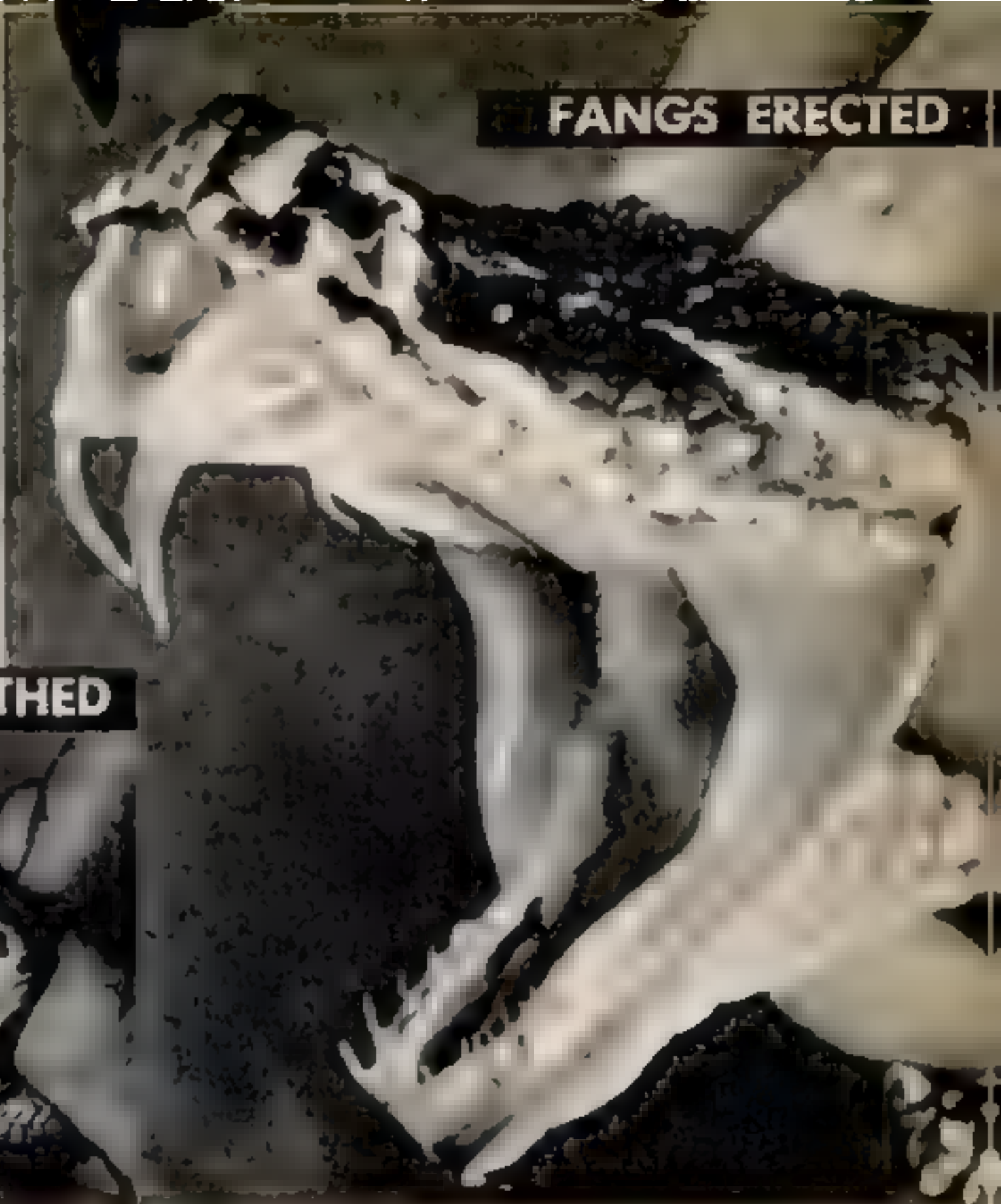
The western diamondback (shown coiled at left) causes twice as many deaths as the eastern species. It is one of the three most lethal snakes found in the United States. Diamondbacks are responsible for a large percentage of snake fatalities.



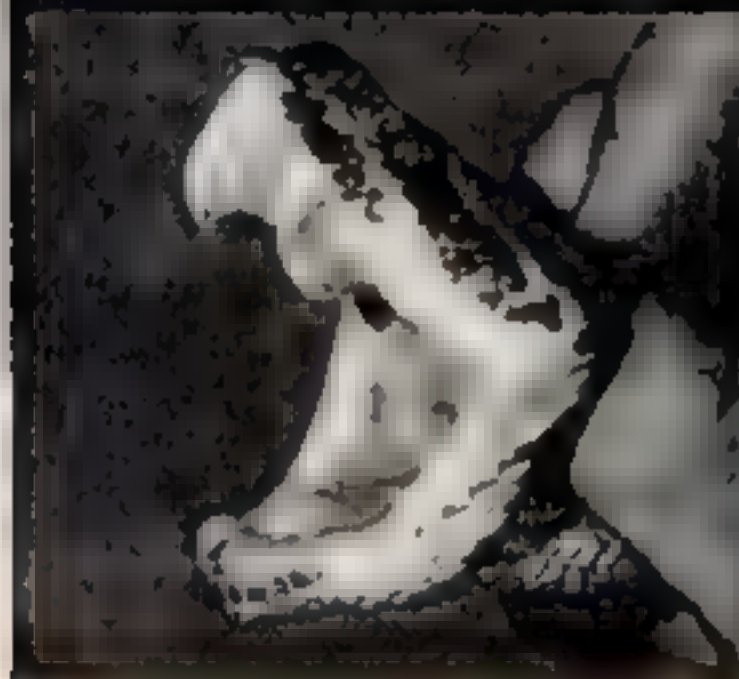
RATTLE?

This is the business end of an eastern diamondback in a menacing pose. In the large picture the fangs are extended for action; retracted into their sheaths in the other view. This snake makes its home in wooded areas of our Southeast, particularly among scrub palmettos along Florida sea beaches. The adult snakes feed largely on rabbits, sometimes on quails

FANGS ERECTED



FANGS SHEATHED



RATTLER'S SOUND RECORDED

How noisy is a rattlesnake? Bella McClurkin, of the General Electric Company laboratory, obtained a rattle (shown left) from a mature specimen and discovered the answer

Using standard equipment for the testing of war materials, the researcher discovered that the rattle made 75 decibels of noise, or the approximate equivalent of six typewriters in action. With the rattle attached to a vibrator, she made an electrical recording



Bombing, strafing, smoke-laying, reconnaissance—they're all in the day's work for the versatile P-38

How Odd-Job Planes Help Win Battles

By HAL BORLAND

Photographs by HANS GROENHOFF

THE utility plane is a paradox on wings. It's a jack-of-all-trades winning battles in a war of specialists. Theoretically, there should be no need for it; there should be a special plane for every job, one able to do it better than any other plane. But that's theory, which holds true only up to a certain point. Beyond that you run into practical factors, which often provide the margin between victory and defeat. And the utility plane is one of the most practical factors we have.

Officially, there are no utility planes. Run through the lists, and about the nearest things to them that you will find are

the fighter-bombers. Actually, however, utility planes are in use every day, on every front, doing interception work at all altitudes, strafing ground installations, escorting bombers, running bombing missions of their own, laying smoke screens, doing all kinds of reconnaissance work. They are the all-around work horses of aerial warfare, developed in that capacity right at the front.

The utility plane was born of necessity. Down in Australia, for instance, when the Japs were lunging southward and seemed about to gobble up everything in sight, there weren't enough planes of any kind, as the boys put it, to rout a flock of buzzards. Defenders fought the first few actions with advanced trainers armed with infantry machine guns. Then they liter-

LONG RANGE. Fitted with auxiliary fuel tanks, the Lockheed P-38 Lightning can go out more than 500 miles to escort bombers, meet an approaching enemy force, or perform other general-utility tasks

RECONNAISSANCE is another job of the flying handy man. Here a camera is being loaded into a P-38. With photographic equipment replacing its guns, the Lightning relies on its great speed for safety





LAYING SMOKE from wing tanks slung on the bomb racks, utility planes help our advancing forces by blanketing enemy positions. The heavy armament of this plane makes it possible for the pilot to supplement the job by some intensive strafing. "Tactics of combined operations" (P.S.M., Aug. 44, p. 100) place a high premium on planes that can turn their hand to any task dictated by changing battle patterns.



BOMBING. At the left, ground crewmen are attaching a 100 pound bomb to a rack under the wing. A P-38 can carry two 1,000-pounders, as seen in the photo below. For a combination of range and hitting power, an auxiliary fuel tank may be carried on one rack and a half-ton bomb on the other. Fighters skip air-to-air bombing.





ONE ENGINE can bring a Lightning home or into friendly territory if the other power unit is disabled. This safety factor, valuable in combat, is even more important in photographic reconnaissance when the unarmed plane may be shot up while carrying pictures of immense value to Headquarters. Feathering the prop of the dead engine reduces the drag

ally wired bombs under their wings and ran bombing missions with them. Moreover, they did invaluable reconnaissance work. So those trainers became utility planes. And when the first shipload of real fighter planes arrived, the flyers carried over and improved their desperate expedients. Fighters, too, became utility planes; and their enforced versatility saved the day. Even the big bombers which came down from the north just ahead of the Japs were pressed into multiple-purpose service.

Things have changed since that critical time, but as recently as late last winter our big four-motored bombers were called upon to assume utility roles at Anzio when the German attack was rolling with all its momentum. The big ships, loaded with ammunition instead of bombs, roared in at tree-top height along with every pursuit ship available and turned the tide with the sheer weight of firepower. They were used as strafers. The exact opposite of this action came soon after, when fighters were called on to double as bombers in the overwhelming blow at Cassino.

Actually, every plane in our hangars can do double duty in an emergency. We are particularly fortunate, however, in having a few planes that are unusually versatile. Of these the P-38 seems to be foremost, with its speed,

range, firepower, and load capacity. All these qualities stand high on the list of characteristics demanded of any utility plane. It must be able to take care of itself, to protect other planes—particularly big bombers—to knock out enemy opposition, and to inflict maximum damage on enemy forces of all kinds. That's a big order.

The primary purpose of any pursuit ship—most of our real utility ships, including the P-38, are basically pursuits—is to meet and beat the enemy in the air. That calls for speed, altitude, swift climb and maneuverability, range, and firepower. The last two are variable factors; on defense the emphasis can be on firepower, on offense it should be on range. But down in the Southwest Pacific, defense has often meant going out and getting the Japs at

Flying over the water, this P-38 was photographed from above by an accompanying plane. The streamlined auxiliary tanks can be seen protruding from under the wings. These reduce the speed only four percent



a considerable distance, and that is where the P-38 showed its mettle. Equipped with auxiliary fuel tanks, it can go to a target or engagement over 500 miles away and get back with a safe margin. Even under these extreme conditions its firepower is devastating. It is noteworthy that when carrying extra fuel tanks its speed is cut by only about four percent.

The Japs learned this the hard way. The boys from the Pacific still smile over what happened when the first long-range Lightnings went out with the bombers. A group of Zero pilots apparently thought the extra tanks would slow up the P-38's and they could have a field day. They closed in, and before they knew what happened the Lightnings had opened up and were running them ragged. Only a few of those Zero pilots got home to tell about their tragic mistake. Judging from interviews with captured Japs, those who did get home believed the auxiliary tanks were actually some new jet type of speed booster. The Nazis have had some painful experience with these long-range escort ships, too, but they never made that mistake.

Japs and Germans alike got another surprise when these utility ships were turned to low-level bombing. In point of fact, the first skip bombing the Japs experienced was a utility job done by Maj. William Benn in a Flying Fortress at Rabaul Harbor. Spotting a Jap freighter while on patrol, he came in at masthead height and lobbed a bomb into its ribs. Then he swung around and flipped three bombs into a Jap cruiser. Both ships simply went to pieces, and Benn was untouched; the at-



FIREPOWER of the Lightning comes in handy on many utility missions. Here an armorer is at work on the 20-millimeter cannon which, with four .50 caliber machine guns, makes up the formidable nose armament

tack was a complete surprise from every point of view. A four-motored bomber shouldn't do such a thing.

And that is one of the major virtues of the utility ship, no matter what kind it is: it benefits from the element of surprise. That, of course, is only an initial advantage. When (Continued on page 210)

LOW-LEVEL HUNTING ahead of invading troops is a common assignment for these planes-of-all-work. Clipping the tree tops, they turn loose their withering fire on troops, tanks, gun emplacements, and airfields. Skip bombing also has a place in this kind of work. With its fast climb, the P-38 needn't fear interference





How Science Made a Better Bee

Amazing new discoveries bring improvement
to nature's masterpiece, enabling the busy
little insect to do a better job for war.

By **ALFRED H. SINKS**

Photographs by **WILLIAM MORRIS** and **ROBERT F. SMITH**

THE tiny honeybee—far more important to both war industry and our food supply than most people realize—is getting a lot of attention nowadays. Though nature has produced few animals as remarkable as these industrious little insects, entomologists and geneticists have found the means to improve on its handiwork. They are actually producing bees that work harder and so produce more honey—bees that are more industrious and energetic, healthier, and better able to protect their bee cities against natural enemies. Truly amazing

MIXED BREEDS. Although renowned for the teamwork and organization that distinguish its communal life, a colony of bees is actually made up of an amazing variety of types. This unusual shot of a group of workers was taken through one of the glass sides of an observation hive at the U. S. Agricultural Experimental Center located at Beltsville, Maryland

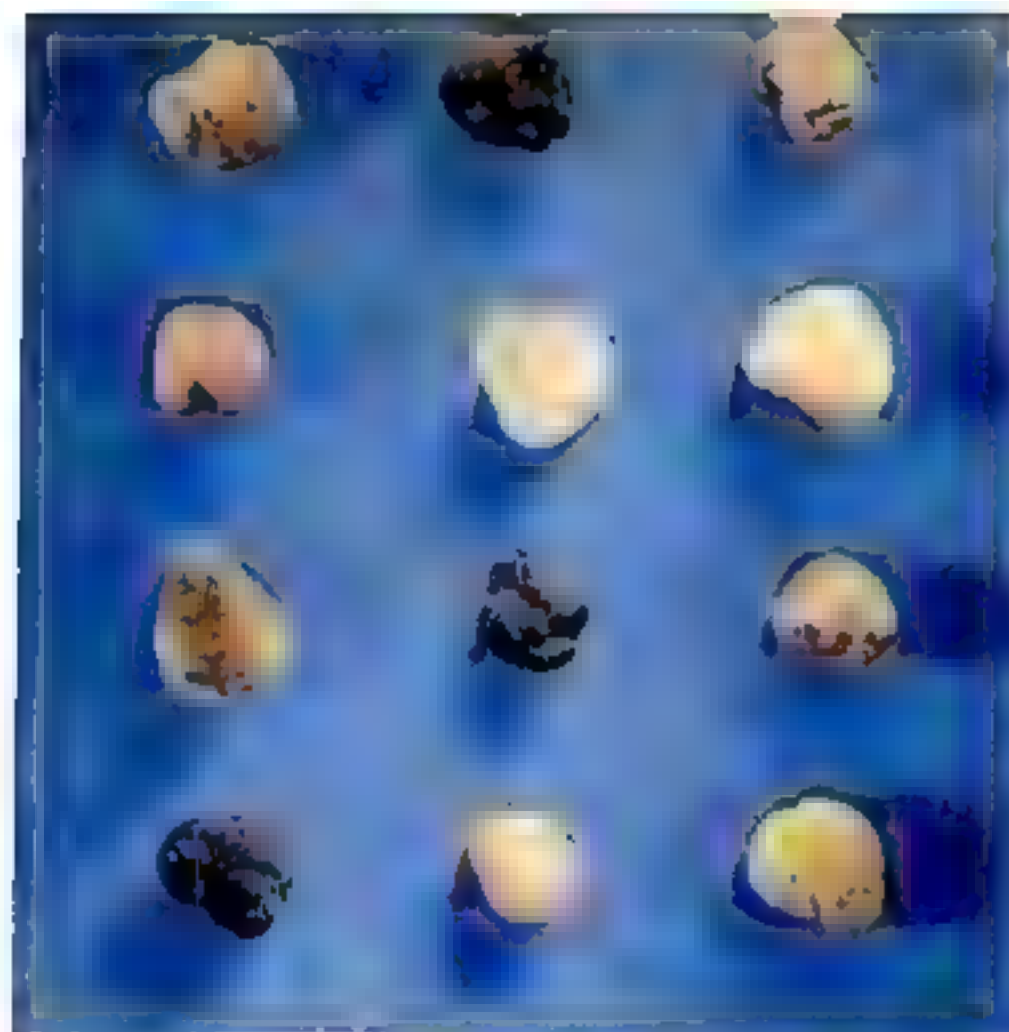
are some of the results of this partnership of science and nature, and its future achievements may be greater still.

Few people know that beekeeping itself is a war industry of first importance, and that beekeepers are classed as "essential" war workers. Coatings containing beeswax pro-

tect every round of live ammunition, small or large, that goes off to war

But this remarkable industry will be no less important after the war. In the production of our food supply, bees do a job far more essential than just storing honey. Farmers depend on them to pollinate at least 50 important crops. Many varieties of apples and other fruits will bear almost no fruit unless pollinated by bees. So growers are rapidly learning the trick of hiring small colonies of bees to work in their orchards, gardens, and cattle-grazing fields just during blossom time.

Pollen which bees bring to the hive and feed their young is rich in valuable vitamins and minerals. Important medical uses may



POLLEN PELLETS are nature's own health pills and may yet turn out to be the bee's most valuable product. Brought back to the hive by the bees and fed to their young, these pellets have been found to be rich in vitamins and minerals and are now being investigated as a possible means of enriching human diet. Varying in size and color, the pellets also vary in content according to their plant source



COLOR AND FLAVOR of a honey is determined by the types of plants that predominate in those areas where the bees gather their nectar. A few of the many types that bees bring home are (from left to right) hairy vetch, fireweed, orange, sabel, coffee, sage, buckwheat. The dark honeys are usually found to have the highest mineral content

BEES' TONGUES vary from the small type shown directly at right to the longer type shown below. The latter, now being produced by artificial breeding, is much the more desirable because it enables a bee to lap up from a flower the nectar that a short-tongued bee may not be able to reach. The average length is about six and a half millimeters

SEPTEMBER, 1944

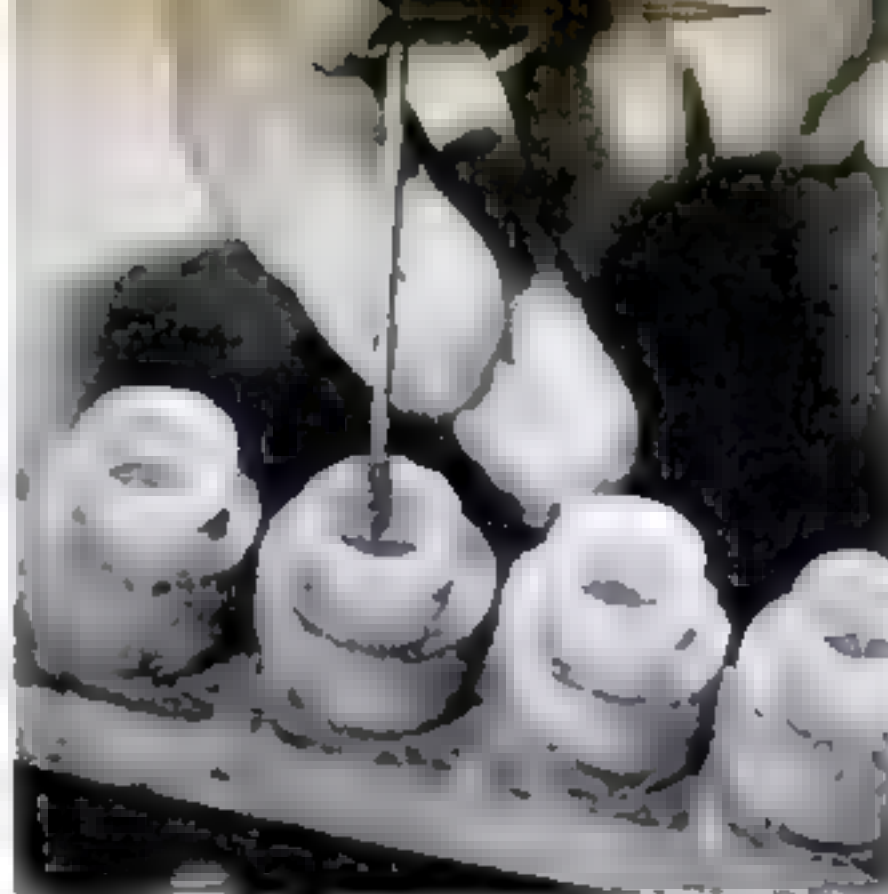


A WORKER "puts the bee" on a gladiolus. Some 200,000,000 pounds of honey and 350,000,000 pounds of pollen are gathered every year by the 5,000,000 colonies of honeybees operating in this country. And this isn't their most important value. Farmers depend on them to pollinate at least 50 of our most important crops. In this connection, the length of a bee's tongue (see below) is important because a plant whose nectar can't be reached will be ignored by bees and thus suffer from inadequate pollination





TO MEASURE BEES' TONGUES, jars with tiny openings are filled with honey and put in a hive. When the bees have taken all they can reach through the openings, what remains of the honey reveals the length of the hive's longest tongues. Individual measurements are made the same way



GRUBS become queens when fed royal jelly, which worker bees will supply continuously only to queen cells. By tricking workers with man-made queen cells (foundations are shown above) keepers can breed queens at will

be found for it. And the 5,000,000 colonies of honeybees in this country will gather in a single year as much as 350,000,000 pounds of pollen—nearly twice the amount of our annual honey crop!

Because bees contribute so richly to our comfort, health, and prosperity, and because they are such fascinating creatures in themselves, scientists have long taken the keenest interest in them. There are various basic races among honeybees. Each is distinct from the others in size, color, markings, length of tongue, size of the honey sac, and so forth. For nearly a century man has been trying to learn just what characteristics in bees make for better honey producers, and trying to improve on nature by careful mating of selected queen bees with selected drones.

Entomologists of the Department of Agriculture and state agricultural experiment stations have been trying to put this study on a more scientific basis. This means making careful measurements of the length of the tongues of worker bees, the size of their honey sacs, their weight, and the amount of nectar they are capable of carrying. By comparing these measurements with the honey production of experimental bee colonies, bee experts determine scientifically the relation between the physical characteristics of bees and their usefulness as pollinators and honey producers.

The length of a bee's tongue is highly important. A bee will not work a flower in which the nectar is too deep inside for her to reach. As a result that variety of plant will suffer from lack of pollination.

American entomologists are far more in-

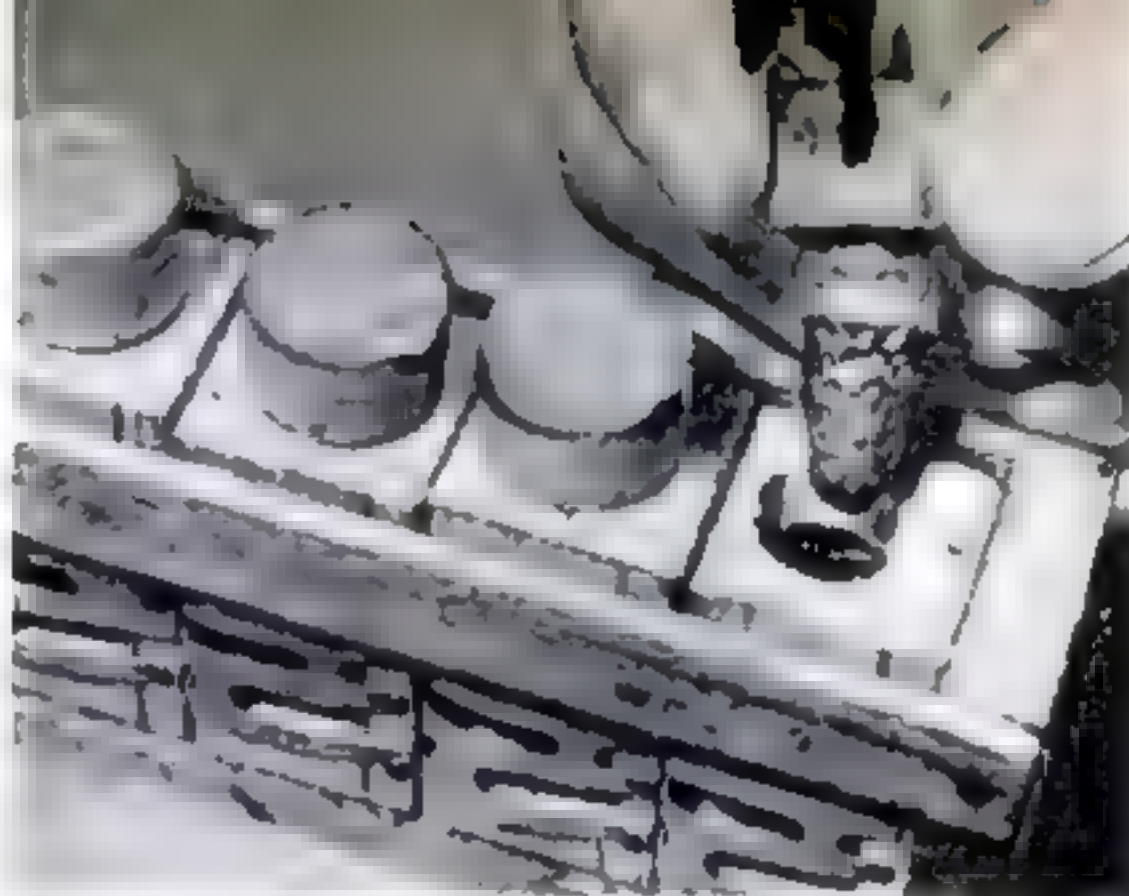
terested, however, in producing strains of bees that are more energetic, hardier, and more resistant to bee diseases.

A stingless bee has long been sought by beekeepers the world over. But the gentler strains have so far proved to be inferior honey producers, and entomologists consider it a waste of time to try to develop bees that literally have no stings.

How do bee breeders help nature to produce better and better bees? Until recently the only method known was one worked out by European breeders a hundred years ago. They selected the best queens and the best drones and carried them to some isolated spot in the mountains. They wanted to make sure that the queen did not mate with some stray drone of inferior strain.

Such selective breeding has shown truly amazing results. In tests at Madison, Wis., superior strains have produced as much as 250 pounds per colony in a good season over and above their own needs, while colonies of a poor strain often fail to make enough honey even to keep themselves alive through the winter.

Still more remarkable success has rewarded attempts to protect bees from disease. So virulent are the three varieties of foul brood that in a few seasons this bee disease may wipe out every bee colony in an area hundreds of square miles in extent. In the middle thirties the bee industry around Middlebury, Vt., was nearly wiped out by American foul brood. In 1936 a Middlebury beekeeper named Charles Mraz noticed that one of his colonies showed an almost miraculous ability to fight the disease. He shipped an egg-laying queen bee from that colony to the experi-



GUARDING THE QUEEN. In nature, the first queen hatched in a hive destroys all the other queen cells. To produce a "queen crop," therefore, queen cells must be put in separate compartments which workers can enter to bring food but from which the hatched queens can't escape

ment station at Ames, Iowa. Today, seventh-generation descendants of that queen are fighting foul brood to a standstill. They seem able to detect the bacillus larva even before it is visible to the human eye.

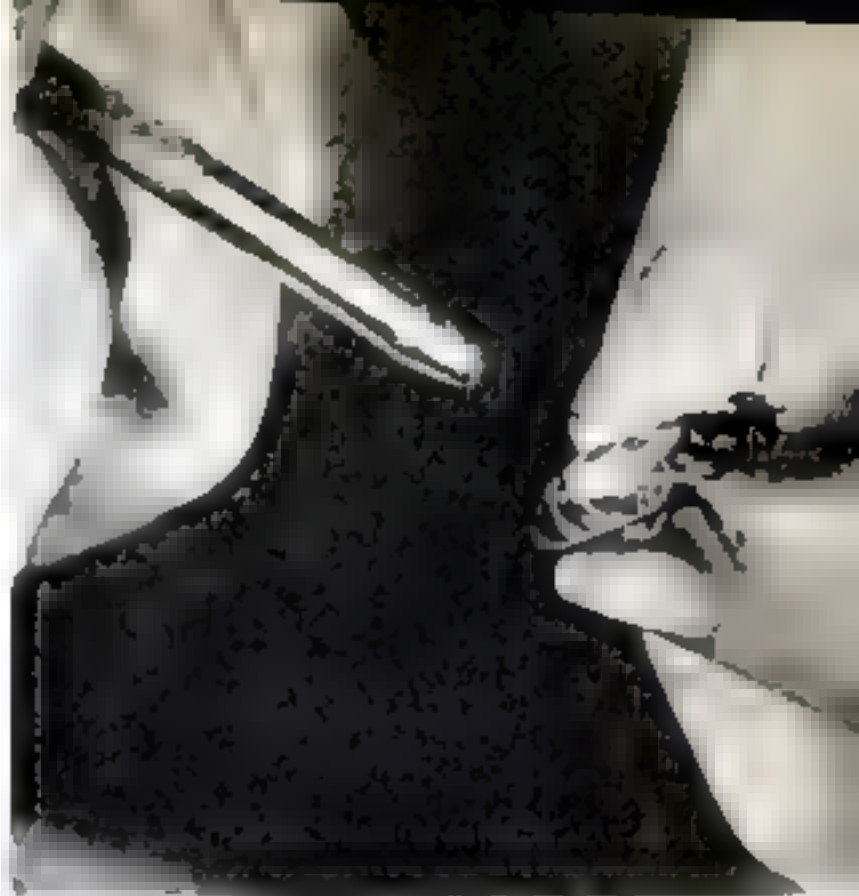
The old method of selective breeding got results slowly, but it could never eliminate the element of chance.

But in 1926, Dr. Lloyd R. Watson of Alfred, N. Y., succeeded in fertilizing a selected queen bee artificially. In this way parentage could be controlled beyond a doubt. Watson's method was taken up and improved by scientists of the Bureau of Entomology.

But one thing still stood in the way of getting practical results. And that one thing baffled the entomologists for 15 years. Because a colony of bees must be strong in numbers to survive, any colony mothered by an artificially mated queen would die out. Such queens never laid enough eggs.

Then, in the spring of 1940, two young American scientists at Baton Rouge, La., discovered that a queen bee makes more than one mating flight in her lifetime. This disproved what bee science had taught for a hundred years. To Otto Mackensen and William Roberts it suggested the idea of multiple mating by artificial means. The theory worked. Queens so treated proved able to lay sufficient fertile eggs to mother a strong colony. This summer—at the Madison, Wis., station, where Roberts now works—there are, for the first time in history, colonies of bees produced by artificial mating. By the old method, only one new generation could be produced in a year. The new method produces as many as ten.

SEPTEMBER, 1944

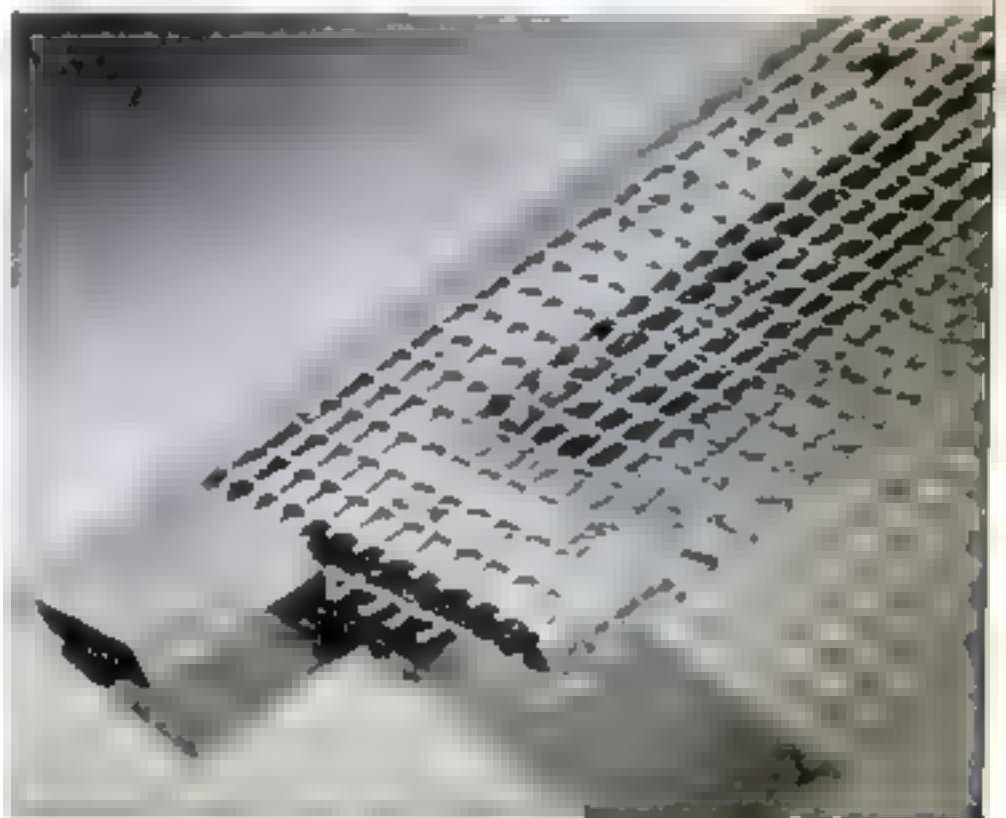


IN CONTROLLED BREEDING it is imperative that each queen be well labeled. This is done with individually colored and numbered paper disks that are cut out and then stuck to the backs of the queens with a small punch



CLIPPING THE QUEEN'S WINGS is done to make sure that this "key" bee of the hive won't stray from home. Queens handle easier than workers because they don't sting so often. Because his stinger is barbed, a worker usually loses it, then dies, once he has used it

"HIJACKING" POLLEN from bees is done by putting five-mesh screens over the opening to the hive. As the workers wriggle through, the pollen is scraped off their legs and collected for systematic feeding of the colony

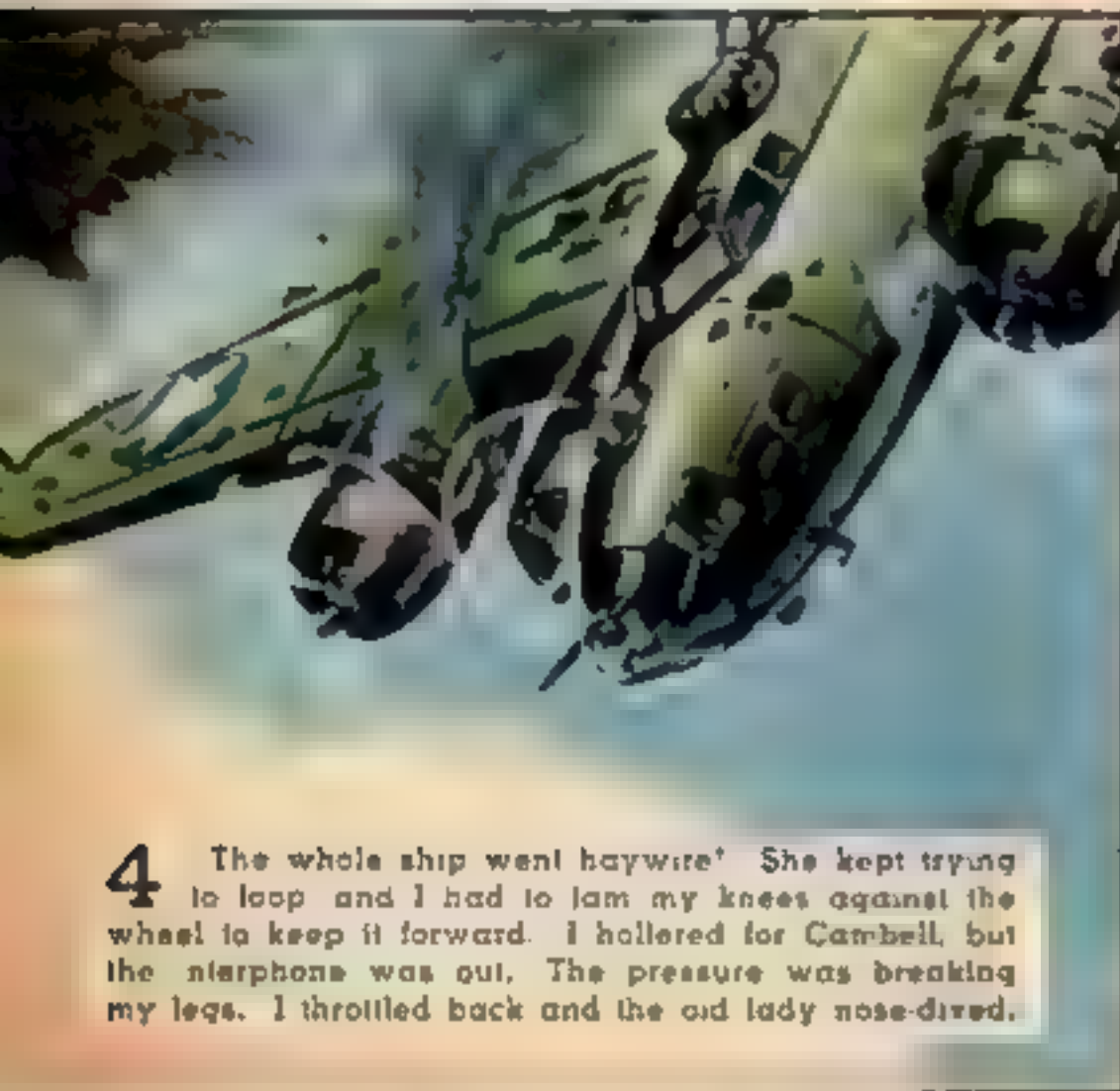


Saved by a Shoestring

By FRANK TINSLEY



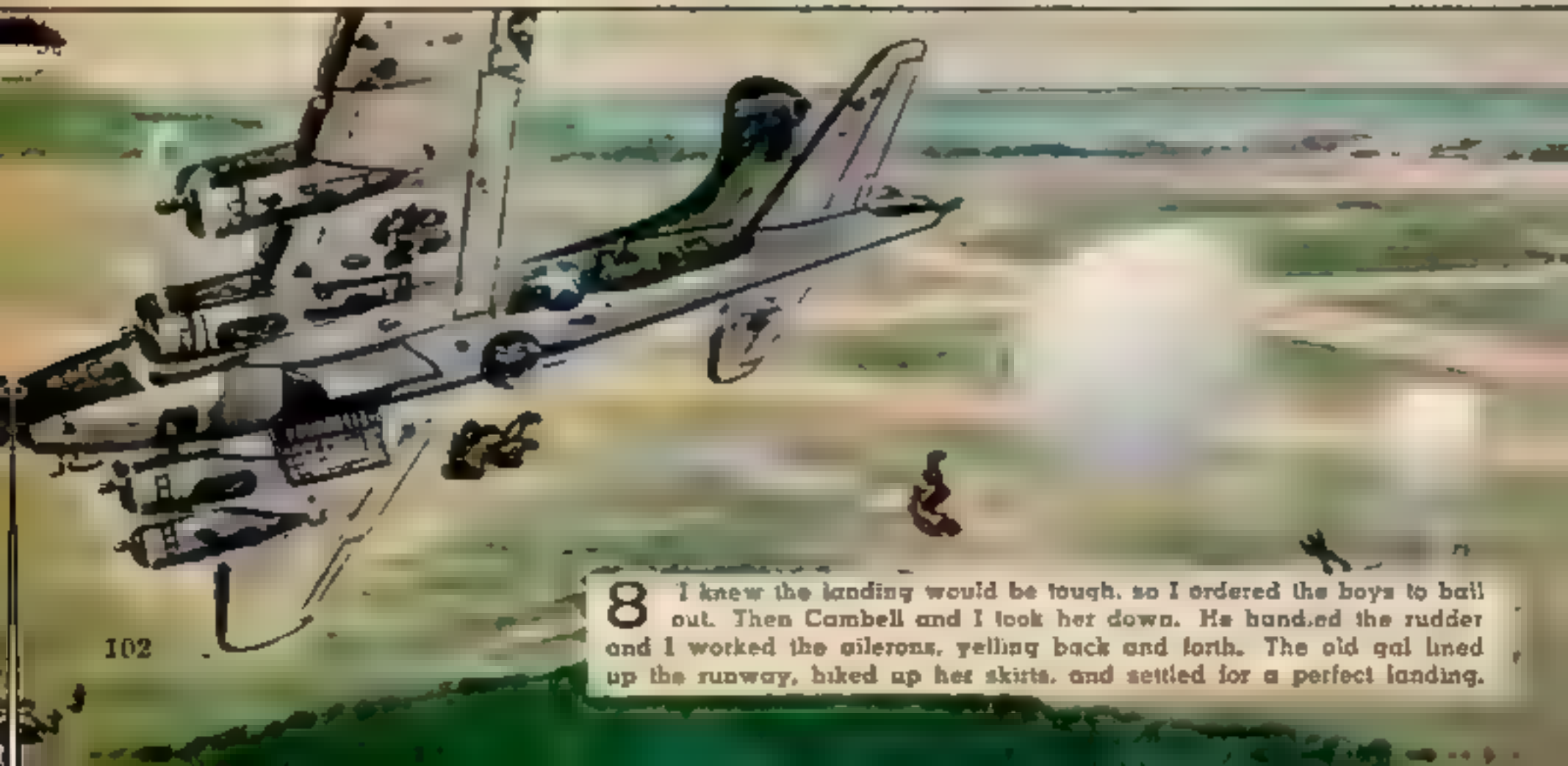
1 During a single combat mission his 64th Charles R. Wardwell of the Northwest African Air Force, captain of a Boeing Flying Fortress, ran into more grief than befalls the average pilot in his entire career. But with Yankee courage and ingenuity he managed to bring both plane and crew home safely. Here's how.



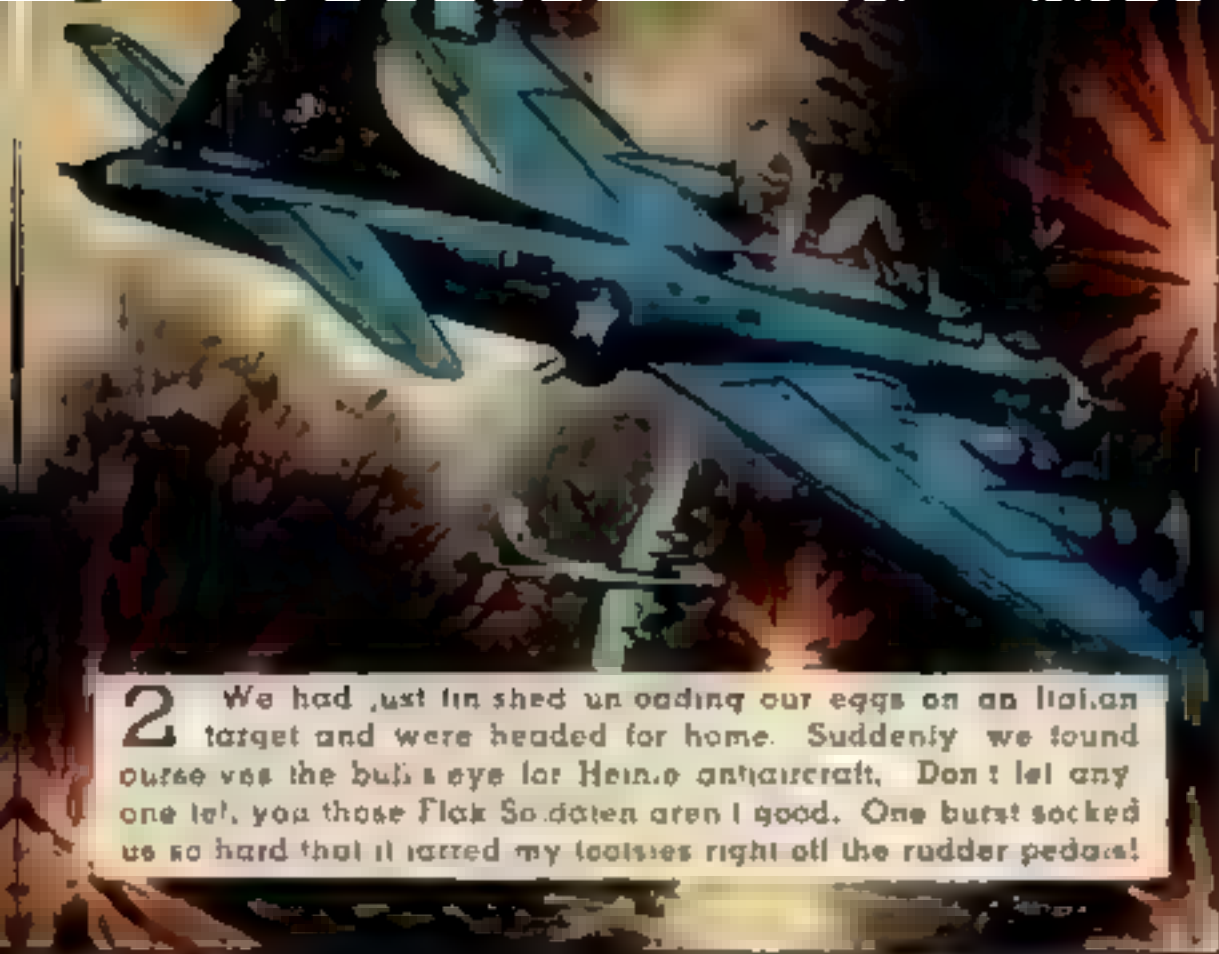
4 The whole ship went haywire! She kept trying to loop and I had to jam my knees against the wheel to keep it forward. I hollered for Cambell, but the interphone was out. The pressure was breaking my legs. I throttled back and the old lady nose-dived.



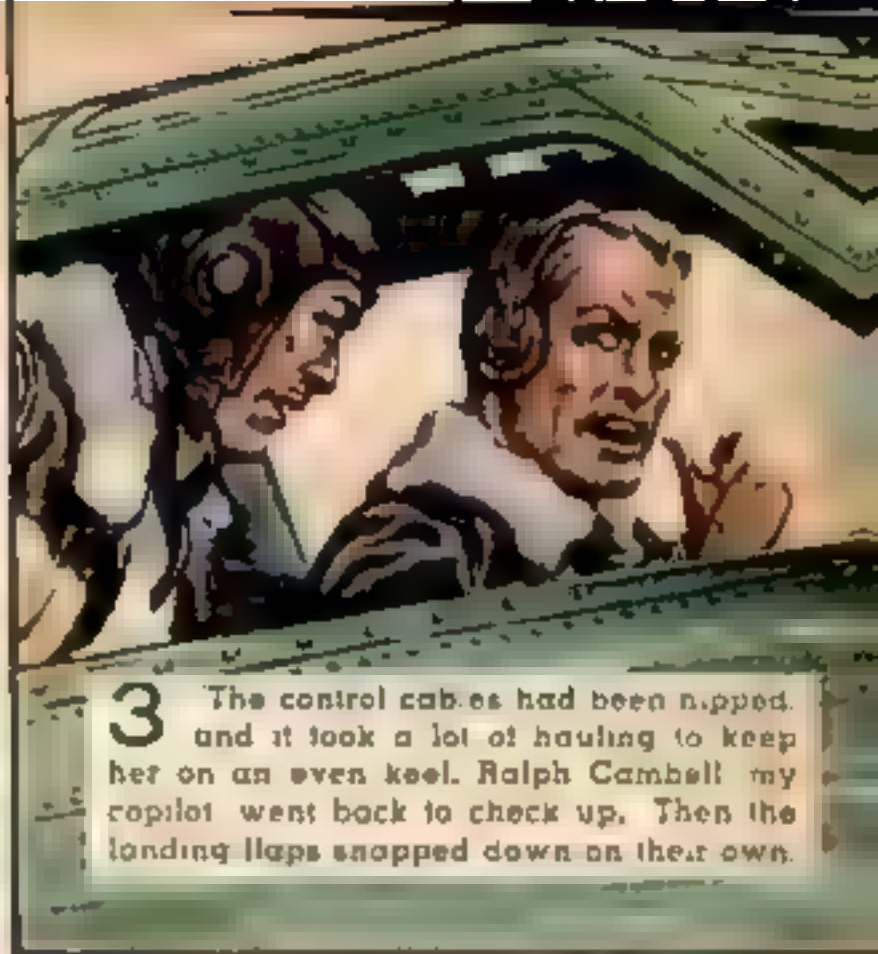
5 From 20,000 feet the altimeter plummeted to 1,000. Then glory be the flaps closed by themselves and Cambell returned. We needed power so I led her a little gas while both of us braced against the controls.



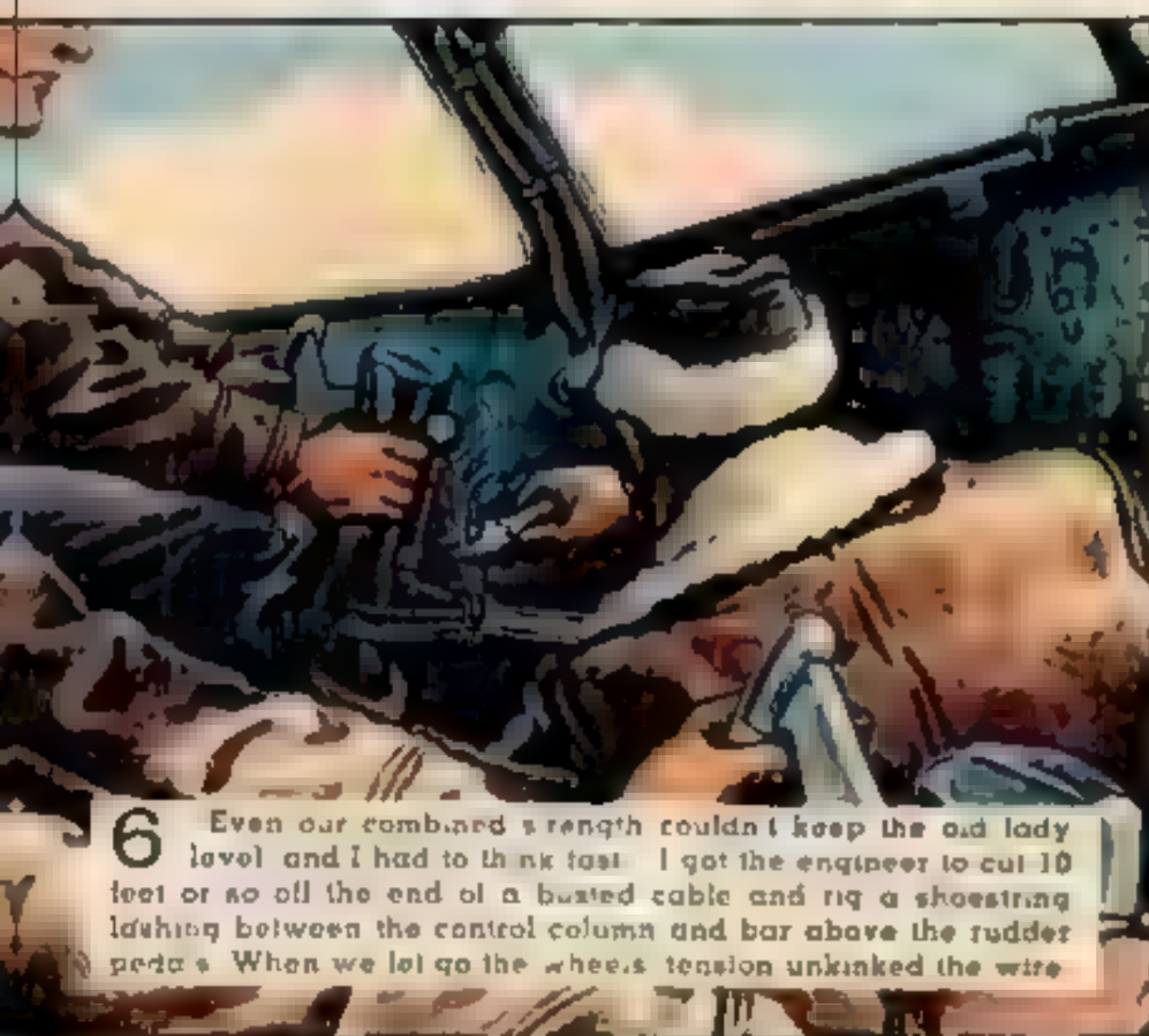
8 I knew the landing would be tough, so I ordered the boys to bail out. Then Cambell and I took her down. He handed the rudder and I worked the ailerons, yelling back and forth. The old gal lined up the runway, hiked up her skirts, and settled for a perfect landing.



2 We had just finished unloading our eggs on an Italian target and were headed for home. Suddenly we found ourselves the bull's eye for Heine's antiaircraft. Don't let any one tell you those Flak Soldiers aren't good. One burst socked us so hard that it jarred my testicles right off the rudder pedals!



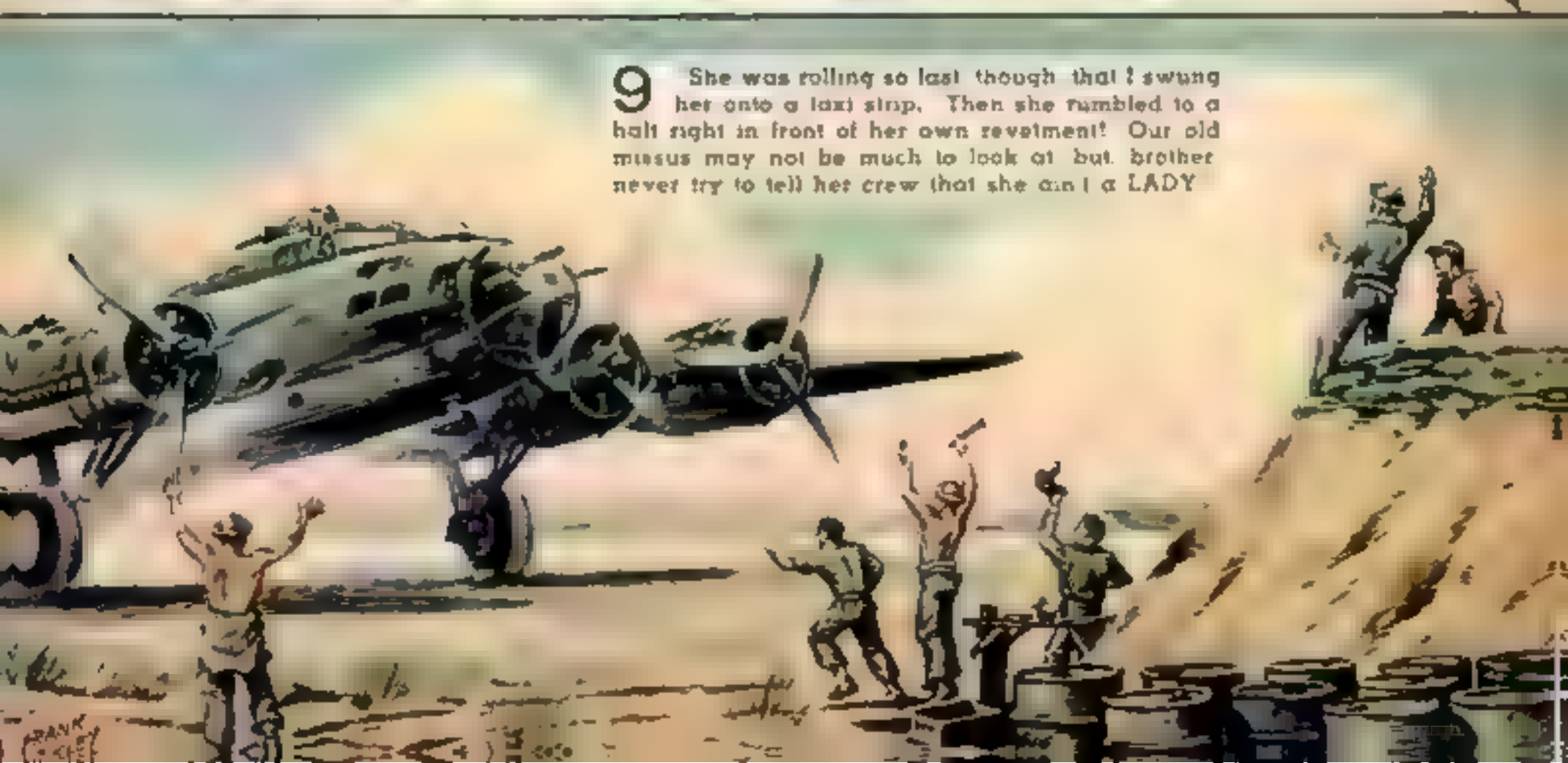
3 The control cables had been nipped, and it took a lot of hauling to keep her on an even keel. Ralph Campbell my copilot went back to check up. Then the landing flaps snapped down on their own.



6 Even our combined strength couldn't keep the old lady level and I had to think fast. I got the engineer to cut 10 feet or so off the end of a busted cable and rig a shoestring lashing between the control column and bar above the rudder pedals. When we let go the wheels tension unknicked the wire.



7 The old lady started to nose up again. I had the bright idea of trimming her with a couple of 50 shells shoved between the control column and cable. With this control we limped home.



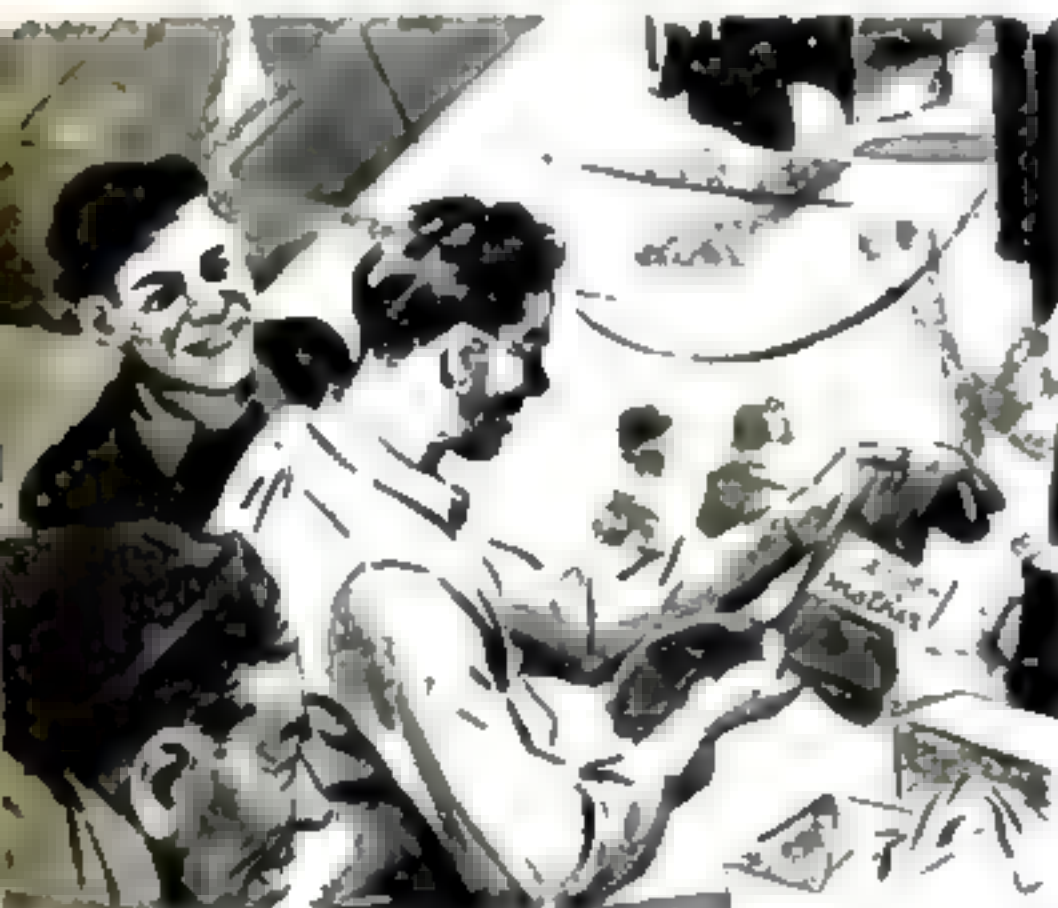
9 She was rolling so fast though that I swung her onto a taxi strip. Then she rumbled to a halt right in front of her own revetment! Our old missus may not be much to look at but brother never try to tell her crew that she ain't a LADY.

Little-Known Sidelights on the Soldier

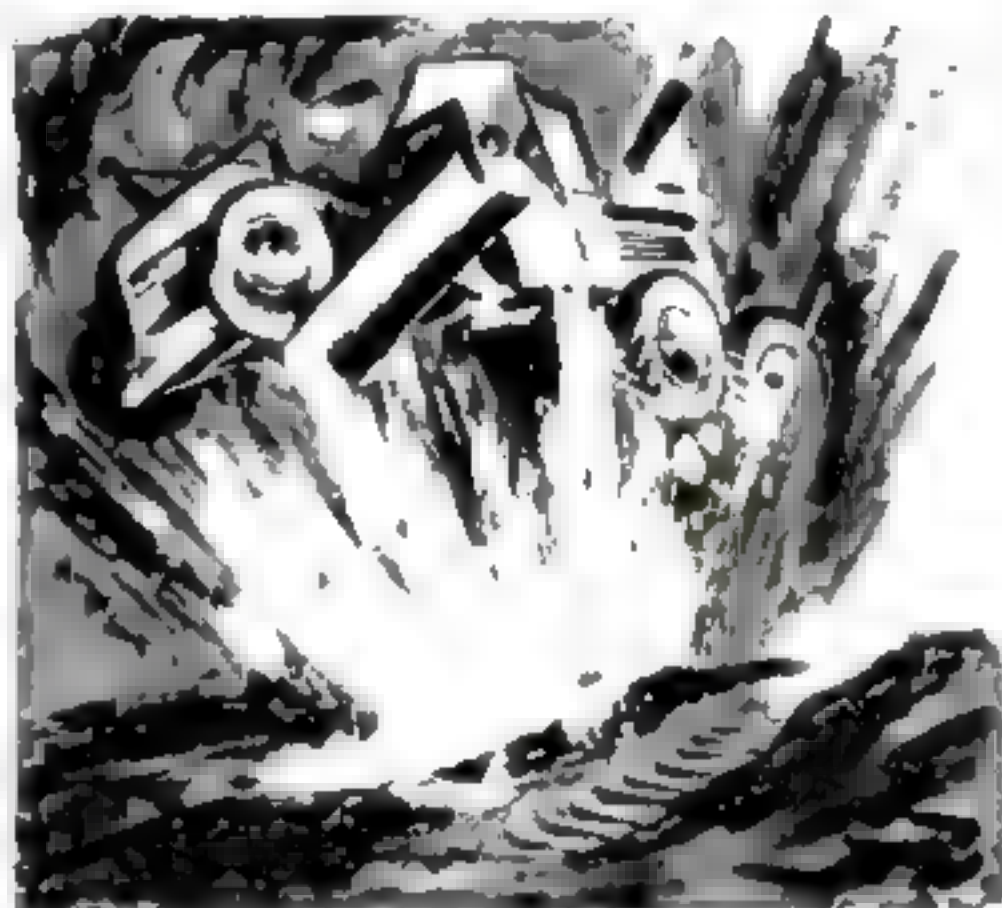
Drawings by FRANK HUSBARD



BORROWING IS TABOO among front-line soldiers who are well-posted on Army etiquette. The idea is that when a man has toted his own heavy equipment, including water, rations, cigarettes, and other necessities, besides arms and ammunition, he's entitled to them himself. His buddies realize this—they are in the same fix—so cadging is out.



MOST WELCOME GIFT to soldiers is heavy wool socks, appreciated in a big way for the comfort they afford tired, aching "dogs" on the march.



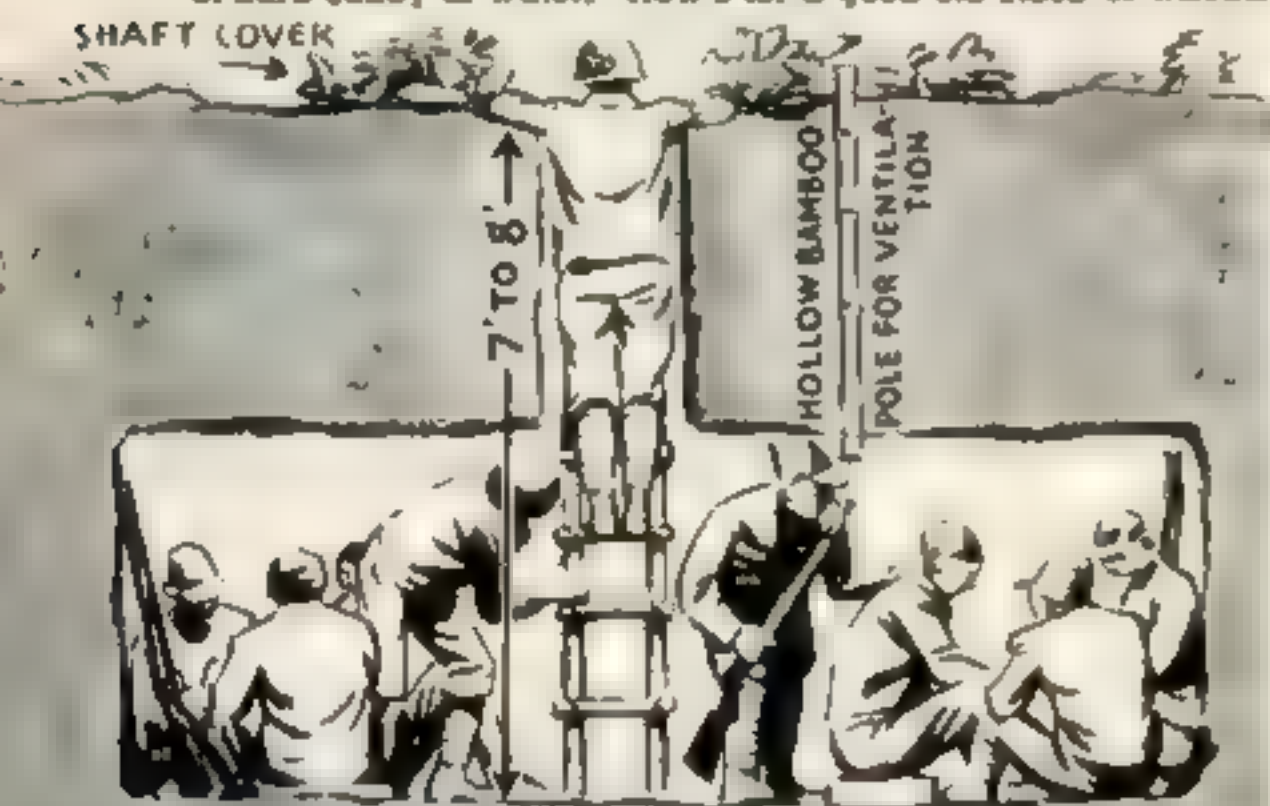
GET THAT BULLDOZER. That's the enemy's ambition. It's because of the importance of good roads built by American troops.

HANDY AS A HAIRPIN was the way one soldier described his metal helmet. A fellow can use it as a drinking cup, foot bath, or stewpot. Under fire, he can dig himself in with it. He can fill it with hot water—water at any rate—for shaving. And when a boat is in danger of swamping, the trusty helmet is right there as a bucket with which to bail.





CAPTURED GERMAN COOKSTOVES are lucky windfalls for homesick GIs who like to show their cooking ability by tossing together messes of this and that. Flapjacks are no trouble at all but the boys learned a real trick when they discovered how to make sirup for them by boiling certain types of hard candy in water. How's for a good old stack of wheats?



JAP FOXHOLES are different. The Nip builds one that holds from three to 35 men. He sinks a shaft seven or eight feet deep and then cuts a cave at right angles.

NO SMOKING is the rule for men on jungle reconnaissance. Smoke of a cigarette can be smelled for several hundred yards.

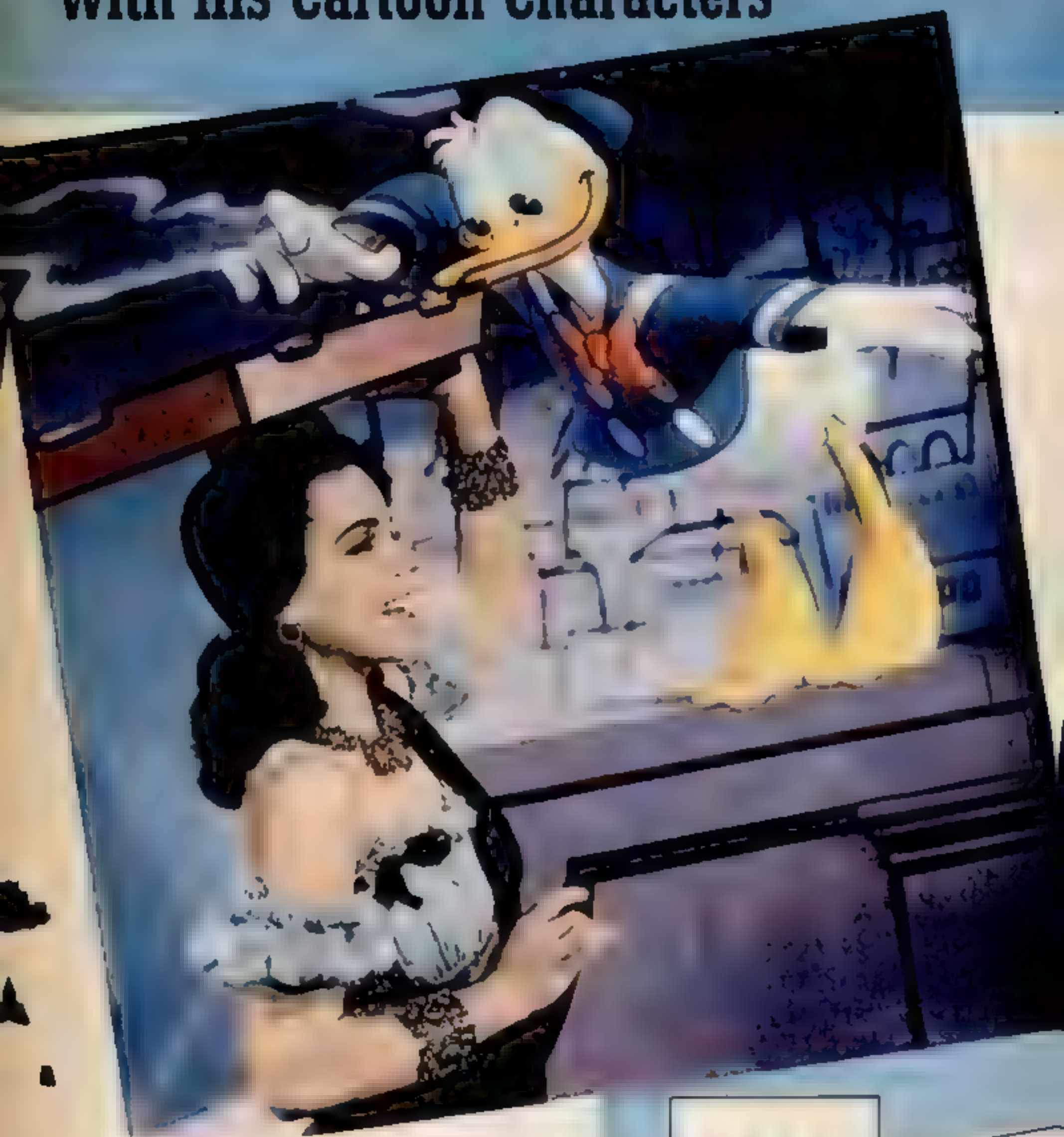


JABBERING JAPS in their foxholes often give away their location to the soldier who puts an ear to the ground.

SHUT-EYE is more restful outside of foxholes. The boys pick out near-by camouflaged spots for sleeping. In case of an enemy attack, they make a dash for the holes.

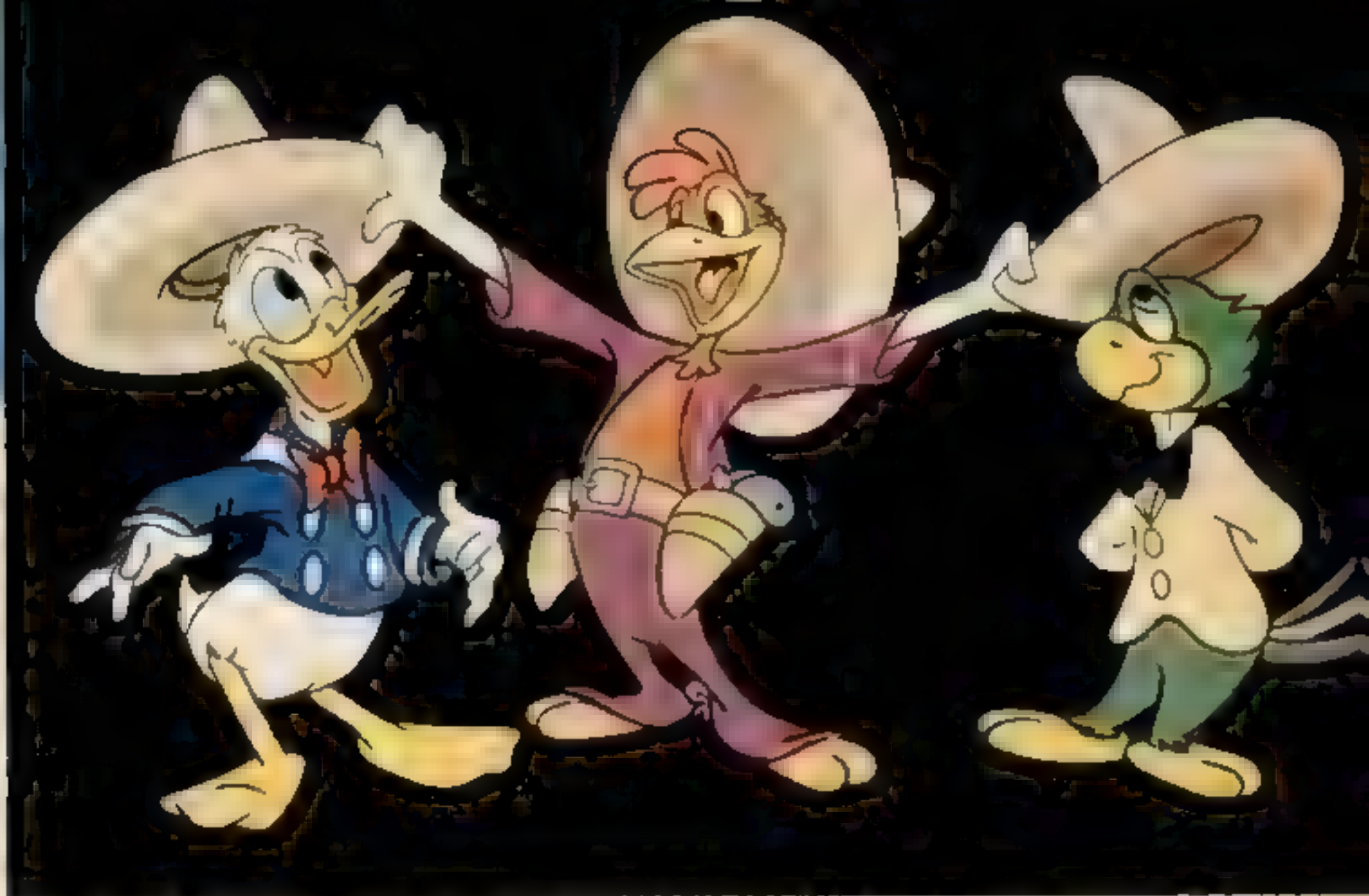


How Disney Combines Living Actors with His Cartoon Characters



Donald Duck swipes fruit from a dancer in Walt Disney's new film "Three Caballeros." This remarkable scene, in which a human figure moves in front of a cartoon character, was made in the rear-projection setup at right





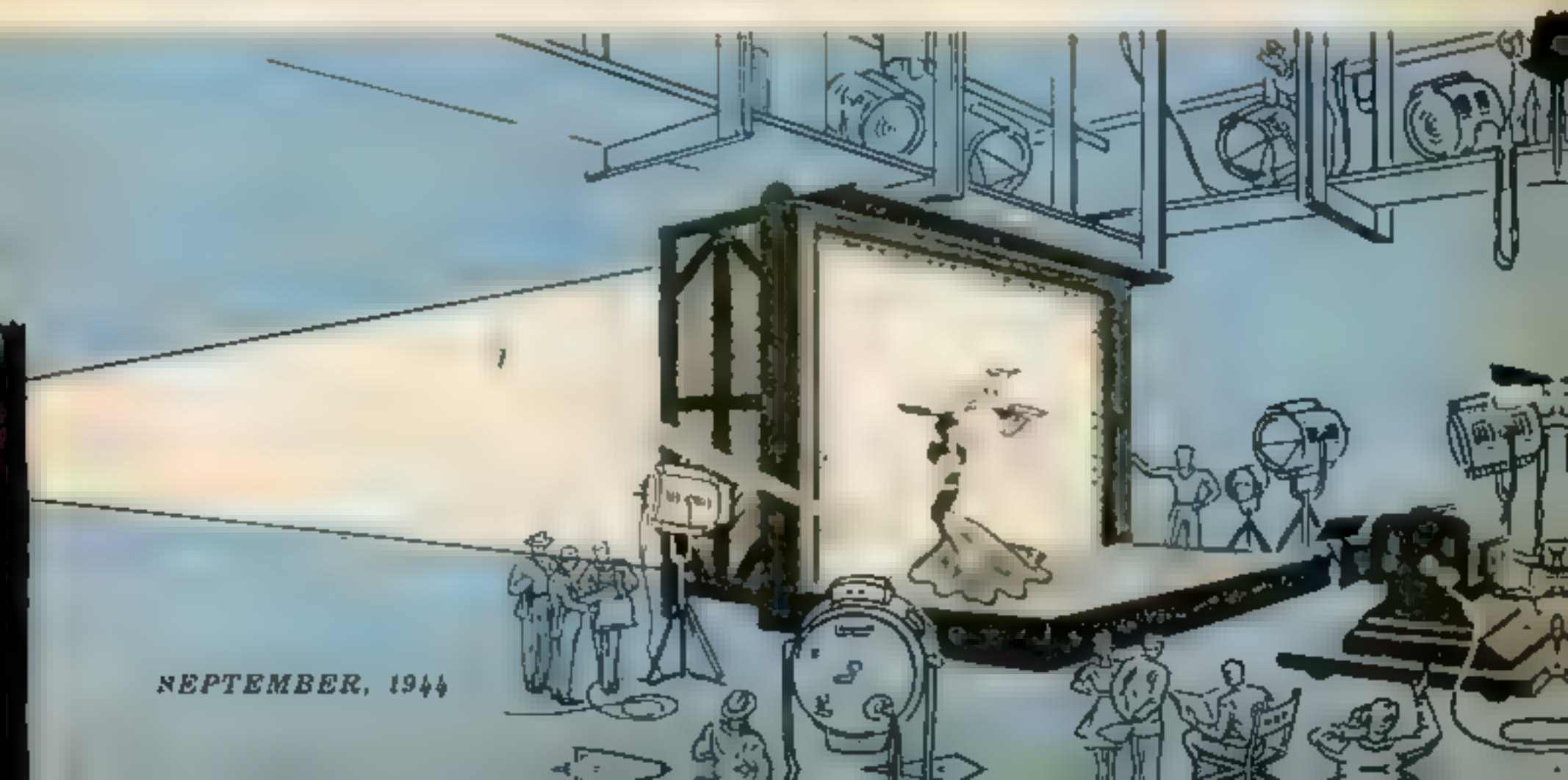
Panchito (center), the new character, had to be individualized both in form and color. He could not clash with either the blue, white, and yellow of Donald or Joe's green, cream, yellow, and vermilion

UP GOES another character in the Walt Disney Hall of Fame. Out comes another surprise from the Disney bag of tricks. To be specific, Panchito, a Mexican rooster with as much personality as Donald Duck or Joe Carioca, is making his first appearance; and on the screen with him will be live, three-dimensional actors.

The new film is "Three Caballeros," a full-length fantasy of Mexico and points to the south. No one will fail to recognize this as a good-neighbor film, but, while Joe Carioca, the parrot of "Saludos Amigos," typified Brazil, or the Portuguese-speaking

part of South America, Panchito leans definitely toward the Spanish side.

Second only to the spell of Disney's propaganda fantasy will be the inevitable reaction of the thousands who will exclaim "How on earth is it done?" It isn't too simple. The film involved the most careful planning all along the line, beginning with the conception of the character. Then came his visualization in the studio, checking up on his background, and—a most important consideration—his color scheme. Panchito must not clash with the blue, white, and yellow of Donald Duck, nor the green,



cream, yellow, and vermillion of Joa Carioca. He must be individual and also look well against the many backgrounds. The studio settled the matter by giving Panchito a yellow beak and feet, red comb, gray hat, and purple outfit. After this, it was a good deal of a chore to find a voice that would make Panchito suitably articulate on the screen. From more than 100 actors tested, they selected Joaquin Garay, an entertainer in San Francisco's Copacabana night club, to speak the rooster's lines.

When such preliminaries have been settled, and layouts, after many conferences, have been approved, the background artists get the "go" signal. They must turn out flat water colors and also oil paintings on glass for use on the multiplane crane, the device that makes it possible for the camera to give proper distance values to the completed picture. At the same time, the animators get busy. They work in front of mirrors and make faces at themselves, seeking to capture in their pictures the expressions that they wish their characters to register.

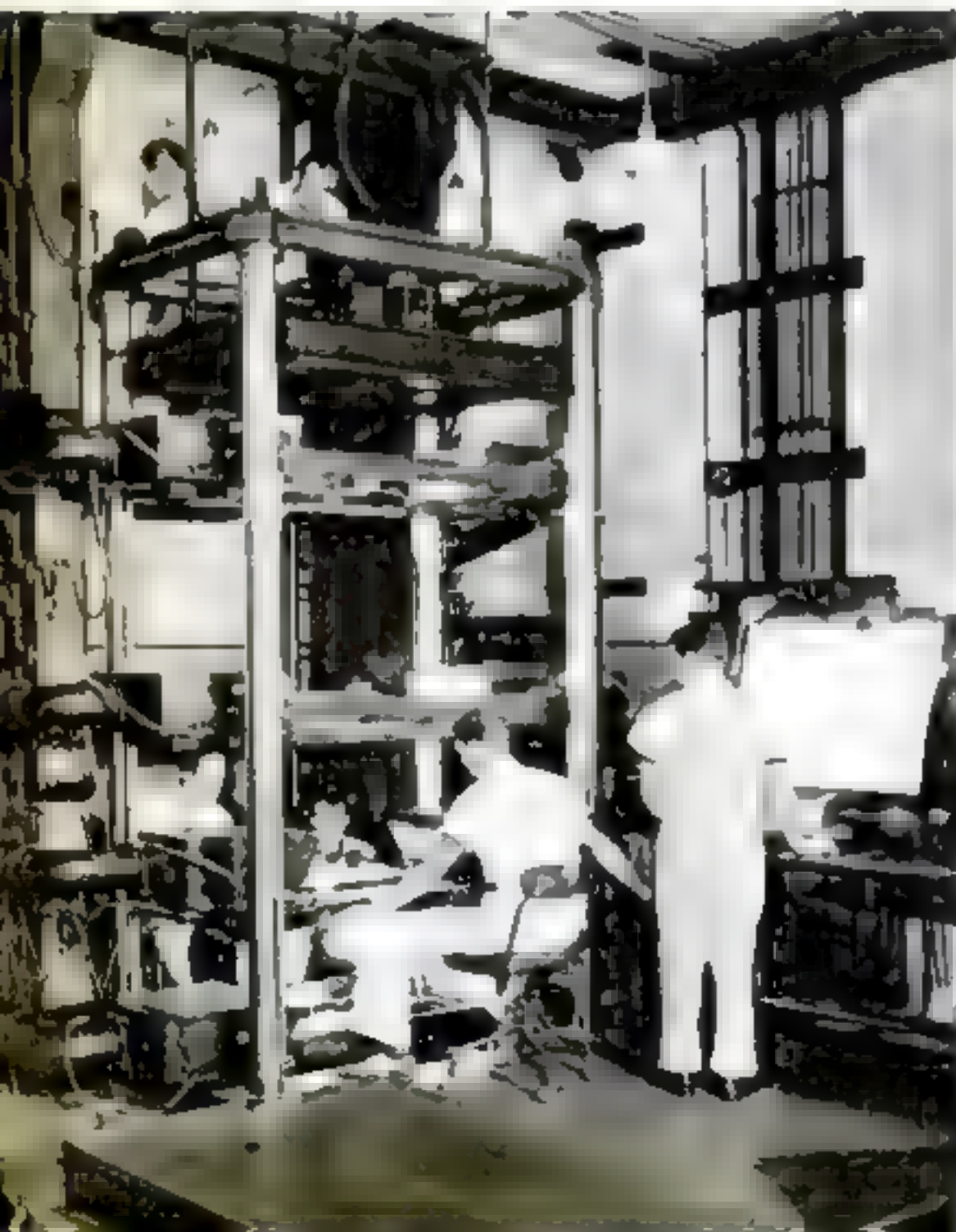
There are other headaches connected with making a picture of this sort. Ward Kimball, who animated Panchito, not only interpreted the scenes as an actor would, but

he acted them out after studying a chart that analyzed the details. These included previously recorded dialogue in terms of single frames of film, the length of each word, the intervals between words, the vowel and consonant sounds, accents, inhalations, and exhalations. If Panchito says "Hello," and the cutting department has indicated that the recorded word occupies eight frames of film, Kimball must produce eight drawings in sequence in which the character's lips move to form the word. An assistant cleans up the rough drawings by tracing over a ground glass illuminated from below, condensing the sketchy lines into definite, single lines. Later these are traced by trained girl artists onto transparent celluloid, after which scores of girls ink the characters in lines of various thicknesses and colors.

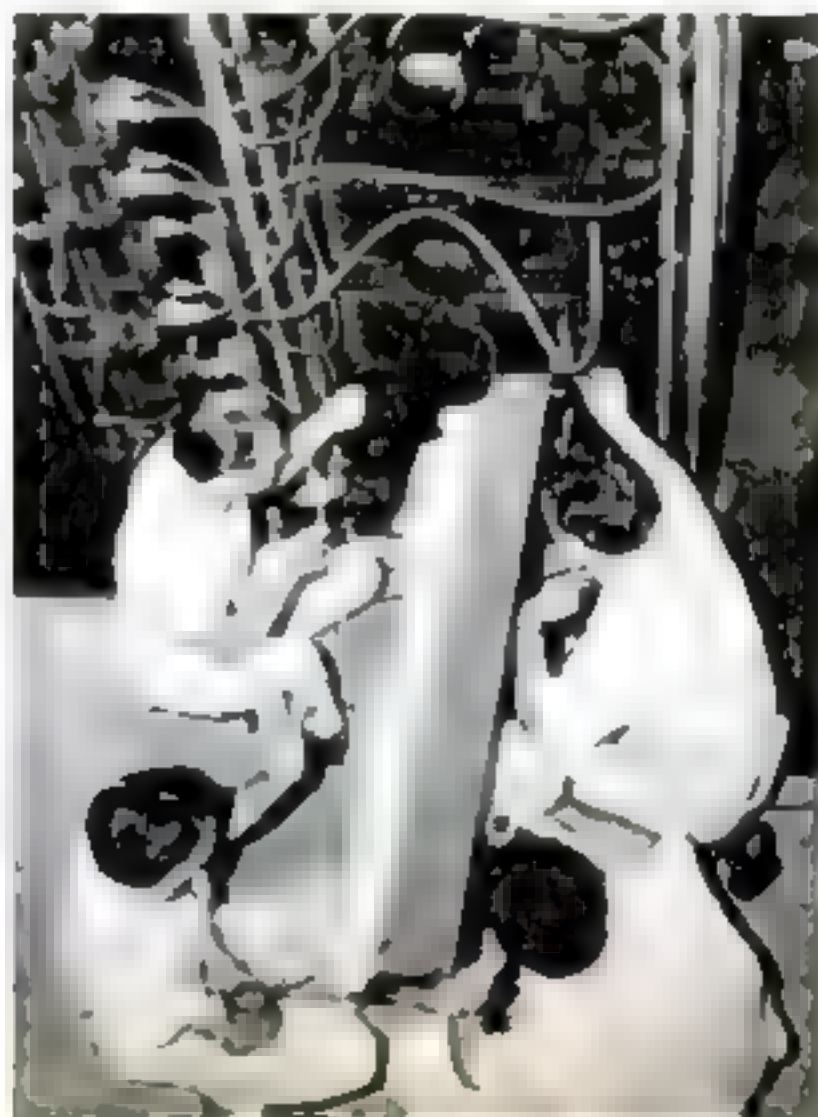
After the inking, the "cels," as they call the celluloid sheets, go to the painters, who fill in between the lines with carefully matched transparent paints. Disney maintains 1,000 compounded color formulas, of which 200 are used in "Three Caballeros." Approximately 150 gallons of paint go into the making of a feature; and the colors cost \$5 a pint.

Three photographic mechanisms recorded

MULTIPLANE CRANE AND CAMERA GIVE REALISTIC DEPTH



This is the multiplane crane (left) that Disney developed to get the effect of distance in his two-dimensional pictures. A camera pointed down from the top photographs various parts of a scene at different levels, thus providing the third-dimensional illusion of depth. Picture below shows operators sliding a background into position in preparation for making the shot.



Panchito's antica. In a soundproofed, air-conditioned room he was placed on the top level of a multiplane crane, a series of transparent movable platforms, or levels fixed to four steel posts. Panchito's cel was held firmly by means of pegs against the topmost glass. Below him, at appropriate distances, there were four parts of the background scene oil-painted on glass. Now, riding his magic *serape* on an aerial tour of Bahia, Brazil, Panchito glides swiftly westward as the clouds forming the distant background float eastward. Peering straight down from its position above the crane, a Technicolor camera recorded the scene in stop-motion, thus obtaining the effect of smooth flight.

The multiplane crane and camera produce and record only cartoon action yet on the screen you will witness scenes showing Panchito, Donald, and Joe moving across and up and down stage among real live singers, dancers and actors, at times appearing to merge with the humans. This cartoon-over-live-action effect was achieved through a further development of the "process projection" already used by all major studios to place actors in front of previously filmed

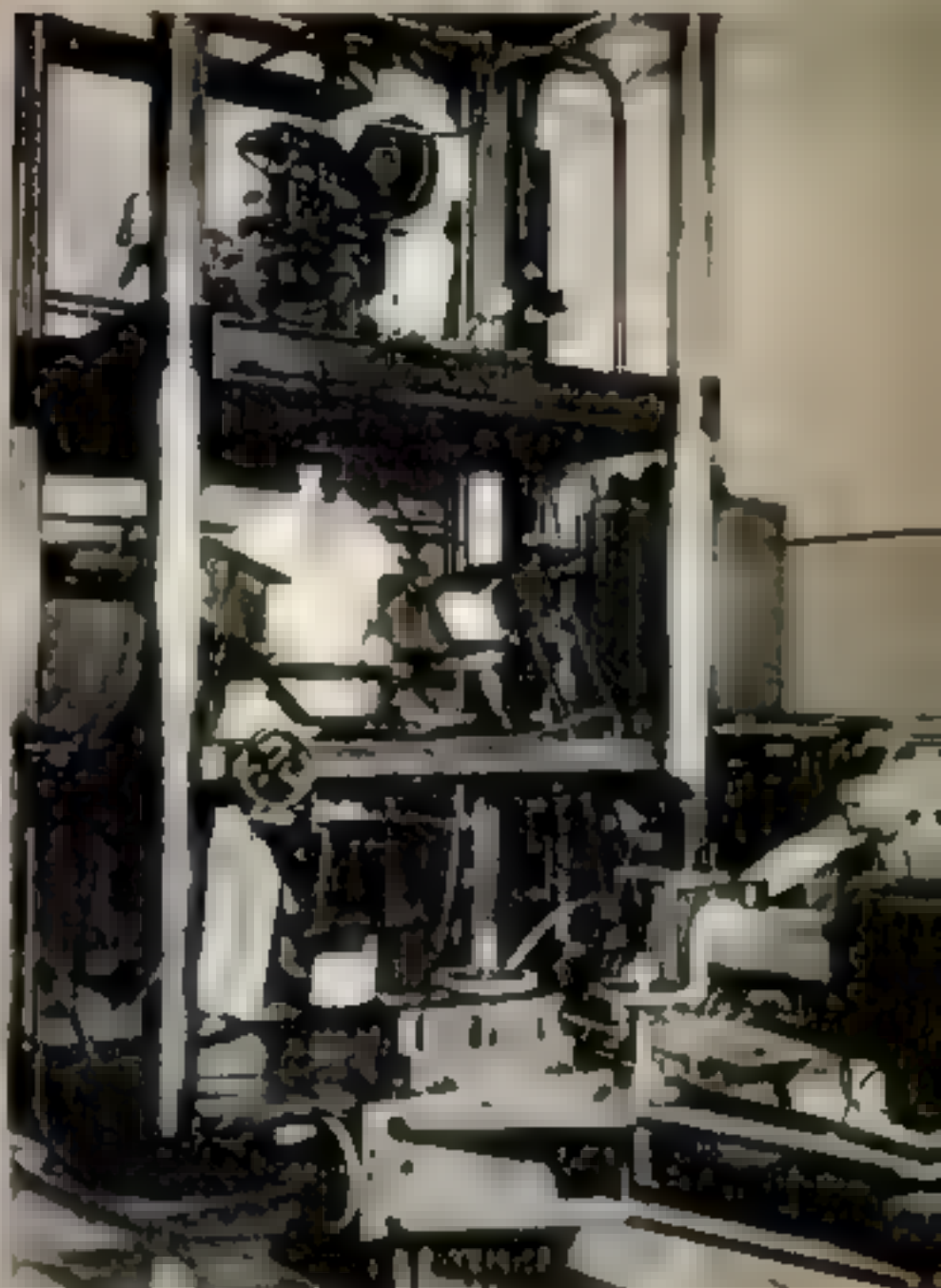
TO CARTOON SEQUENCES



The camera's dissolving shutter, seen above, has an integral counter that permits adjustments to within 1/10 degree accuracy. Below is shown an operator adjusting light bulbs for lateral alignment of the filaments. Front-surface mirrors concentrate light on the subject



"REAR PROJECTION" PUTS ACTORS BEHIND DRAWINGS



When cartoon characters are to appear in front of living actors, the job is easier than when it is the other way around. A movie of the live action is projected onto a front-surface mirror, which reflects the image onto a small screen. Transparent "cels" of cartoon characters are photographed against the screen by a camera mounted above. In the photo below, a cel showing Donald Duck and Joe Carioca is being cleaned. The mirror is seen below the table





The new character, a cocky little rooster of Mexico, was born in the imagination of Ernie Terrazas, one of the Disney studio's ace story men, who is shown here with a few of his preliminary sketches. When Panchito was sketched as a character hundreds of studio workers began turning out the more than 150,000 paintings that were needed

backgrounds. Disney's small projection outfit could place cartoon characters in the foreground, but live actors couldn't perform before a screen about twice the size of this magazine and so several crews got busy on large-scale projection. Music and songs were recorded, and the cartoon action was timed to fit them. Optical experts designed and ground special quartz lenses to deliver maximum light from the projector. The sound crew set up a translucent plastic screen measuring 14 by 20 feet, placed the projector 50 feet distant on one side and the camera 25 feet away on the opposite side. The arrangement provided for the living actor to perform on the stage in front of the projected action of the cartoon, and

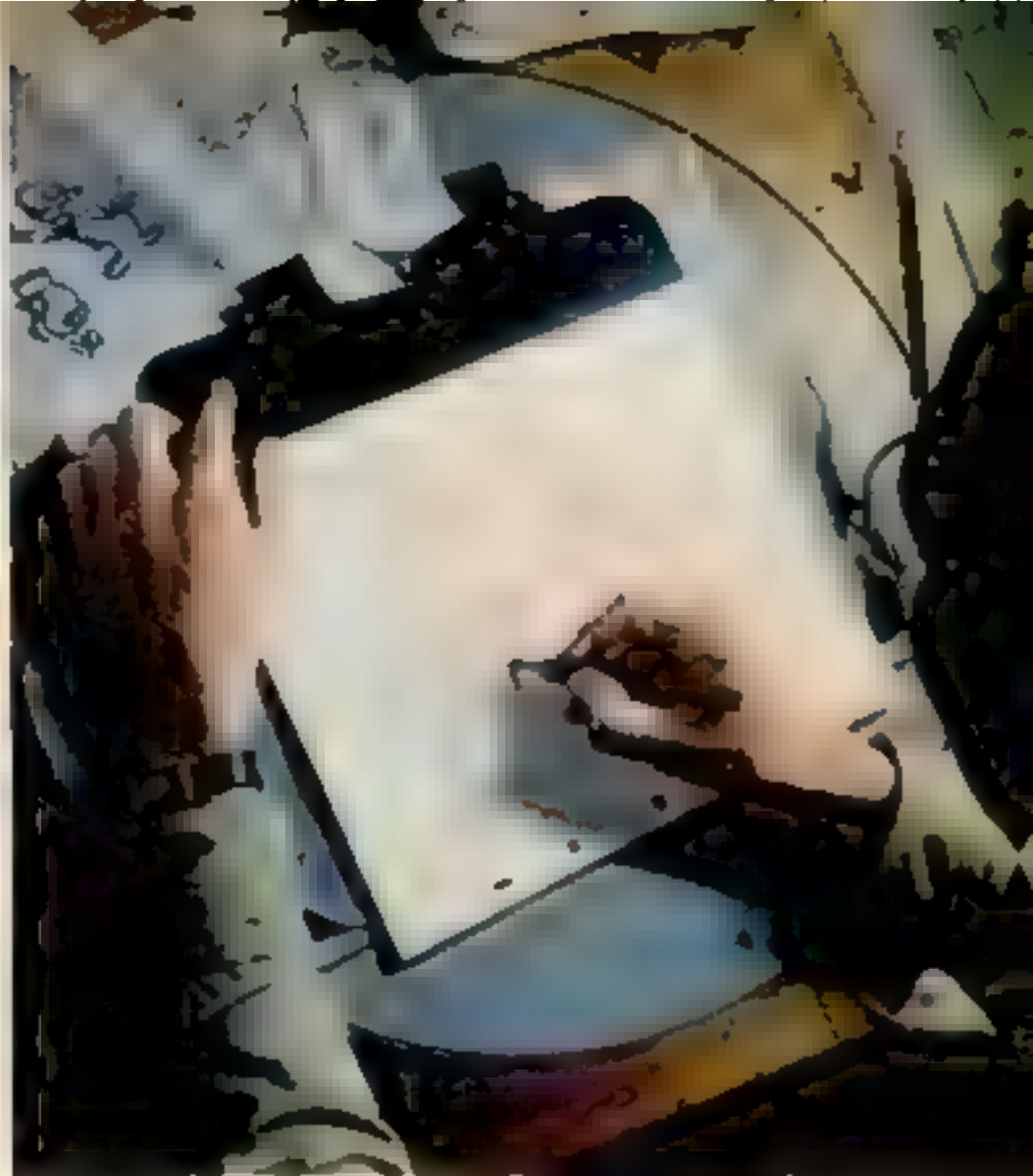
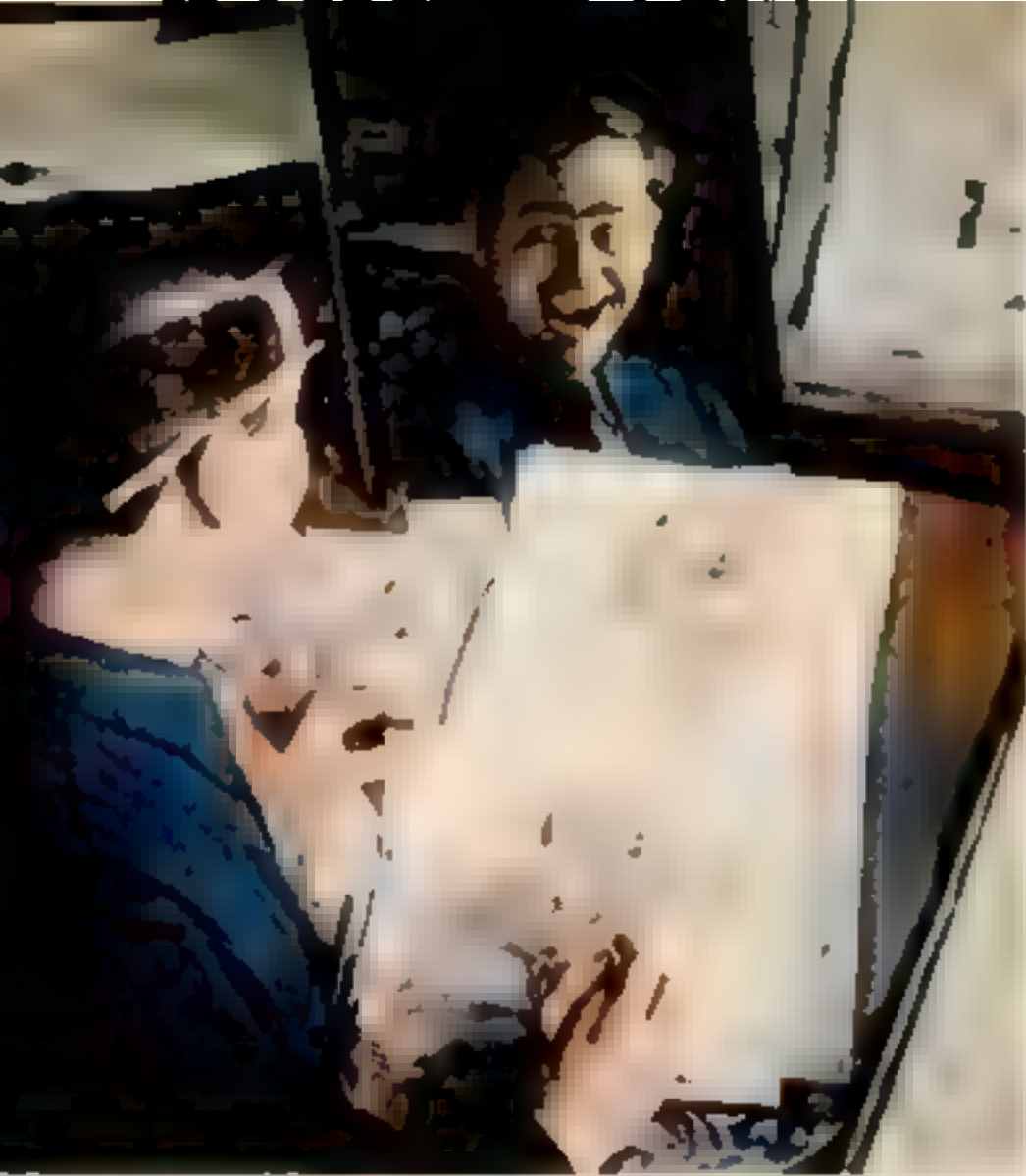
for the Technicolor camera to record both

Disney then shot the first combination sequence, a close-up of Donald Duck stealing fruit from a tray carried by Aurora Miranda as she walks by in the foreground. Aurora's songs, Panchito's comments, Donald's chatter are all parts of the picture but these scenes are shot silent and the lip movements synchronized to sounds recorded earlier. One of the more outstanding qualities of the Disney pictures—apparently effortless production—hangs in the balance as "Three Caballeros" comes to the screen. Will mystification outweigh story interest or will Disney's genius make plausible the mingling of animated pictures with equally lively people?



The backgrounds against which the Disney cartoon characters act must be authentic. In painting them Art Riley works from travel folders and other reliable sources. Some of the backgrounds run into big money





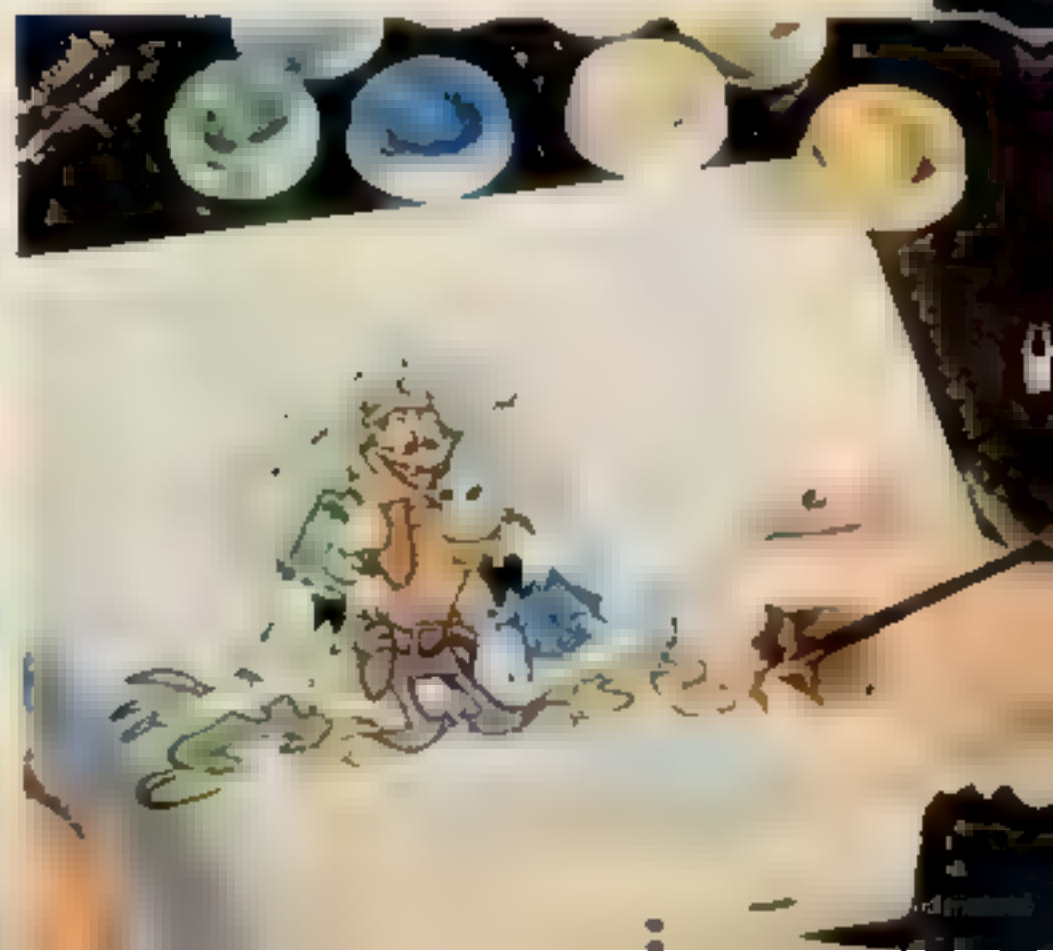
1 GETTING EXPRESSION calls for self-analysis. Animator Ward Kimball makes faces at himself in a mirror to get the expressions he wants his character to register. After artistic facility, one requisite for the job of animator is the ability to act. If Ponchito says "Hello," Kimball must produce eight drawings in sequence showing his lip motions in pronouncing it

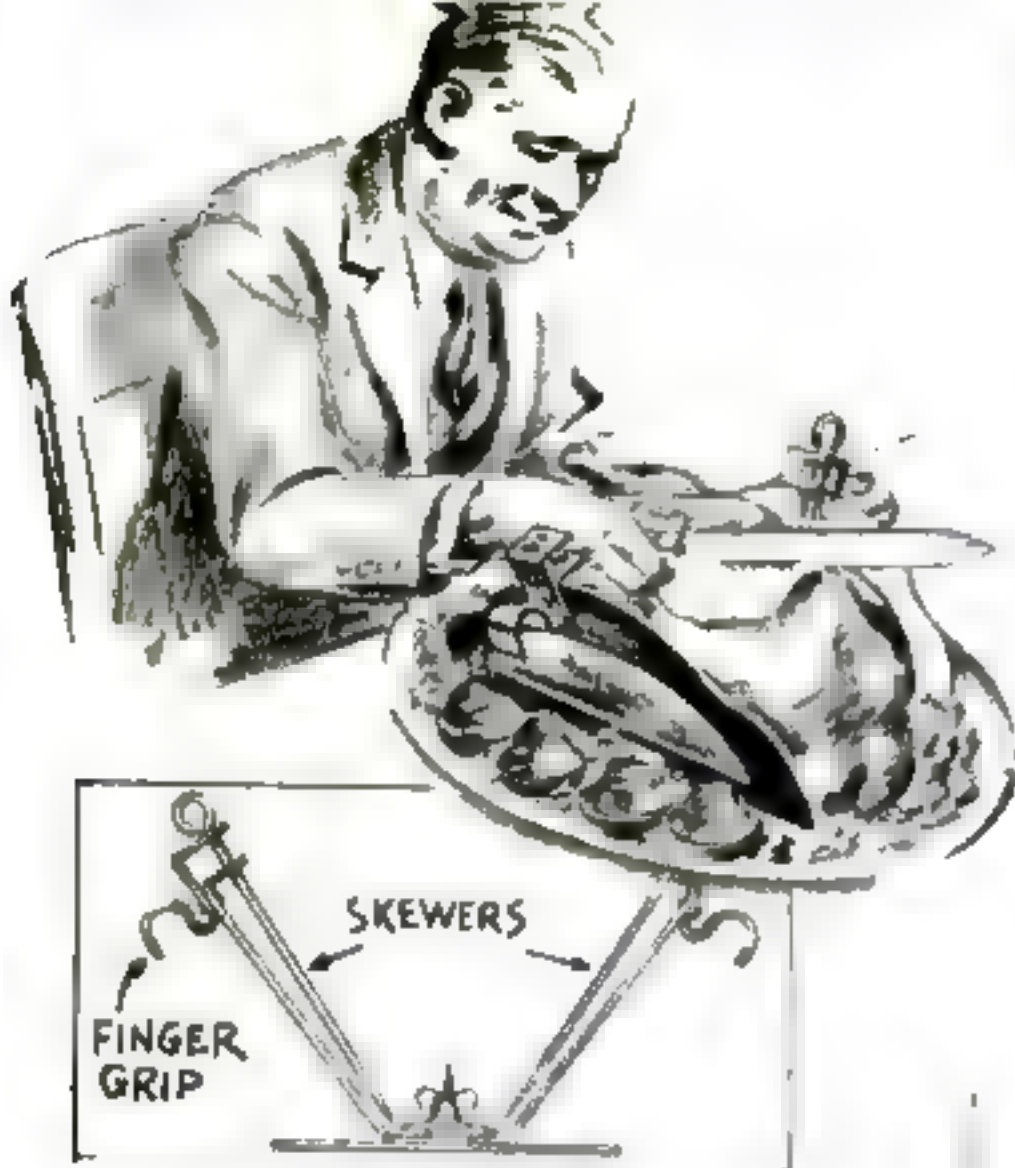
3 INKING IN THE LINES in various thicknesses and colors is the next step. This helps develop the character and preserve the individuality expressed by the animator. The lines must match exactly, for they will be multiplied in length and width when projected onto the screen. One scene may require several thousand of the inked cels, all made with precision



2 CLEANING OUTLINES is a necessary follow-up of the first animation. The originals are placed on a ground glass, which is illuminated from beneath it, and experienced artists clean up the drawings by condensing the rough lines into definite single lines. Later on, these drawings are traced by girl artists onto sheets of celluloid

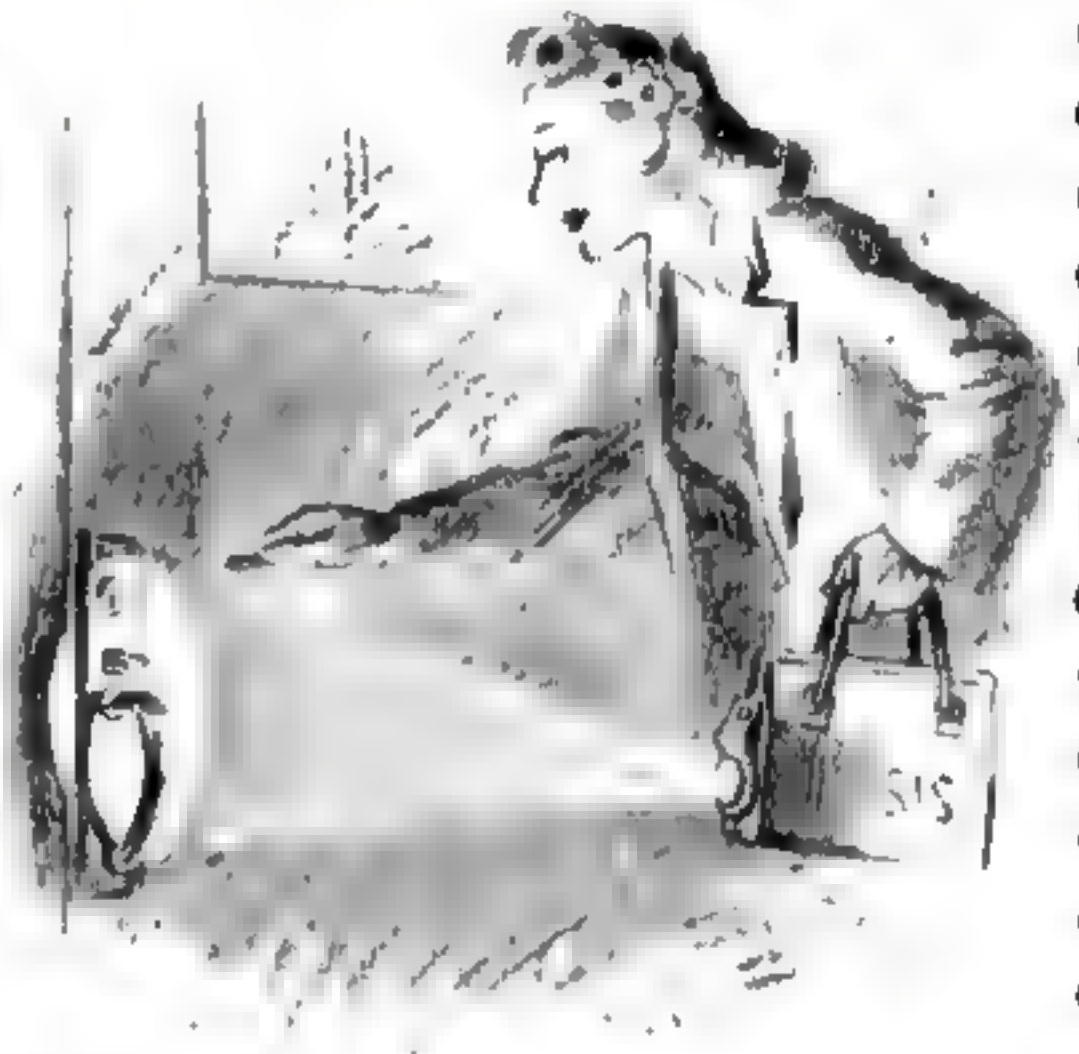
4 APPLYING COLOR is the exacting task of clever girl artists using paints that are carefully matched with previously set standards to make sure that each character will look the same throughout the picture. Approximately 150 gallons of paint and 200 different colors go into the making of a picture. The paint costs \$5 a pint





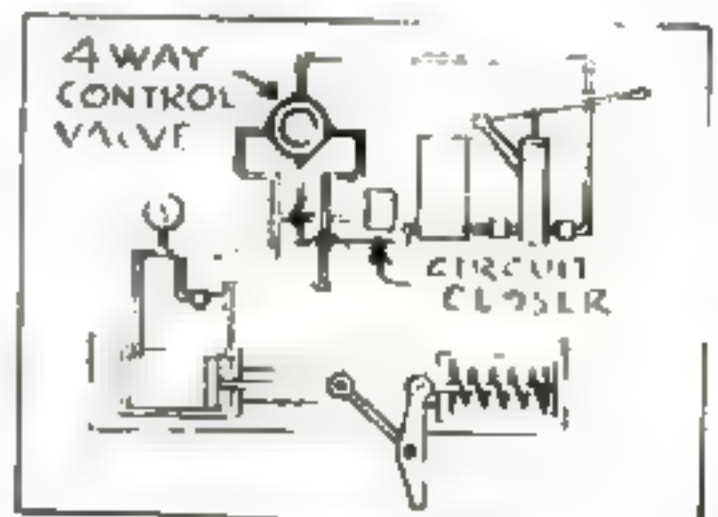
TURKEY ON THE TABLECLOTH is no problem with a nonskid carving device. A wedge-shaped affair, it holds the bird firmly on the platter, allowing the host to carve with confidence and finesse. Two side members are provided with finger grips and adjustable skewers; the base, perforated to vent gravity drippings, is adapted to a flat surface. This unit can also be used in the cooking operation. When placed in the roasting pan, it cradles flesh or fowl in such a position as to cook to best advantage. All parts can be readily disassembled. Edward A. Farish, of Washington, D. C., is the inventor.

LOOKING FOR THE KEYHOLE in a darkened doorway can be a nuisance unless one has a flashlight handy. With this in mind, Col. H. B. E. D. Cross, of Stroud, Okla., designed a support for flashlights that can be attached to the bottom of such commonly used articles as handbags and brief cases. The support, made like a flap, wraps around the flashlight and is secured with metal snap fasteners. A slot in the casing is just over the switch so that the light can be turned on instantaneously. When carrying a flashlight in this way, it is also possible to illuminate the interior of the bag itself by making adjacent openings in the reflector and the bottom of the bag.



SHALLOW WATERS and uncharted coasts need hold no terrors for small boats, according to Charles A. Goins, of Tampa, Fla. He has designed a hydraulically operated device that gives warning when the craft is about to run aground or strike a submerged object. Extending from a stream-

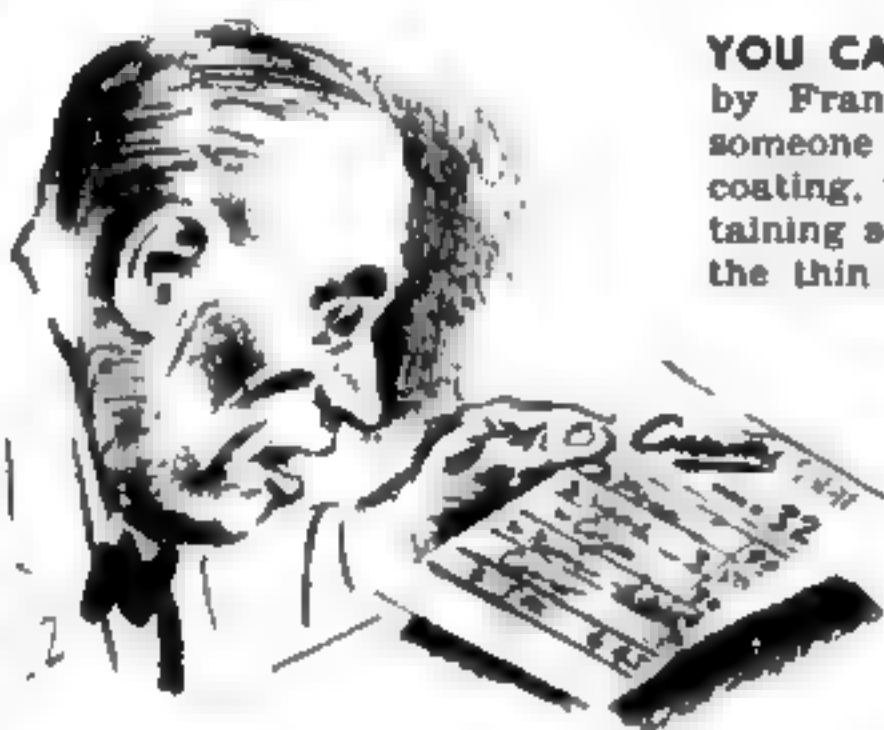
lined housing in the keel, a pivoted arm engages any underwater hazard and operates a piston to compress the fluid in a cylinder. Through a system of pipes and valves inside the boat, the pressure operates a circuit closer to ring a bell or give some other audible danger signal.



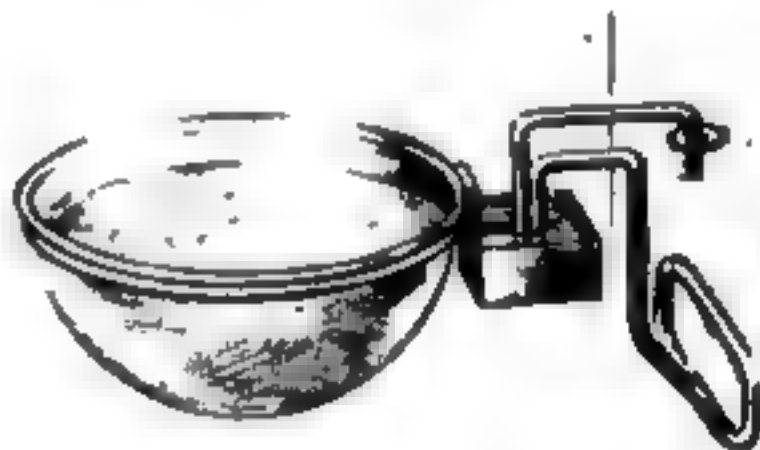
ELSIE IS CONTENTED when milked by a suspensory-type apparatus that is easily applied and reduces "strangulation" to the minimum. This unit comprises a C-shaped hanger of tubular construction, which can be saddled on the cow from either side. A leather strap under the upper arm causes the hanger to rest lightly on the cow's back and prevents chafing. The lower arm is forked and supports a bail on the combined teat cluster and milk receiver. Since this bail has a two-point suspension, Elsie can shift her stance without affecting the vertical position of the milk receiver. Inventors are John A. Schmitt, Milwaukee, and Lloyd F. Bender, Waukesha, Wis.



YOU CAN'T ERASE on a new kind of paper invented by Francis L. Simons, of Montclair, N. J., without someone being the wiser. Each sheet has a two-ply coating, the bottom layer being white, the top one containing some coloring material. When erasure is made, the thin colored surface is removed, leaving an easily detected white area. Attempt to cover up an alteration or erasure with water color is not practical, since the shade of the coloring matter is almost impossible to match. This safety paper can be used to foil dining-check chislers and other frauds.



TRAP FOR INSECTS. Bird feeders or plates of food for the family pet are common attractions for ants. To protect them from such pests, Auguste C. Schiffman, of Hayward, Calif., has designed the bracket unit seen at right. A ring supports the article, and interposed between it and the bracket is a well of liquid insecticide. Ants journeying toward the ring are drowned.



CURE FOR HOUSEMAID'S KNEE is a kneeling dolly. Designed by F. T. Cooper, Cincinnati, Ohio, this movable knee rest makes floor scrubbing faster, more efficient, and less wearing on the "benders." Mounted on wheels or casters is a metal plate with two concave moldings. The knees rest comfortably in these hollowed sections, which are padded with sponge rubber or some other soft material. Centered in the headboard is a small light that can be switched on when overhead lighting is insufficient to show up grime and stains. The bulb is powered by a battery installed in the platform.



As nearly automatic, in spite of its weight and caliber, as human ingenuity and electrical research can make it, this 90-millimeter plane-killer stands framed between two of its own shells. Standard equipment for the armed forces, this weapon has attained an almost incredible effectiveness. Its 15-foot barrel can be wound down to five degrees below the horizontal for use against armor.

How We Developed Guns That Think for Themselves

Antiaircraft artillery has come very far in this war. Huge automatic weapons, aimed with superhuman accuracy, pick enemy bombers from the stratosphere.

By **DEVON FRANCIS**

IN THE Southwest Pacific, not so long ago, a battery of four American antiaircraft guns, firing just 22 rounds apiece, made pyres of 12 out of 18 attacking Japanese high-level bombers, averaging a kill for every 7 1/3 shots.

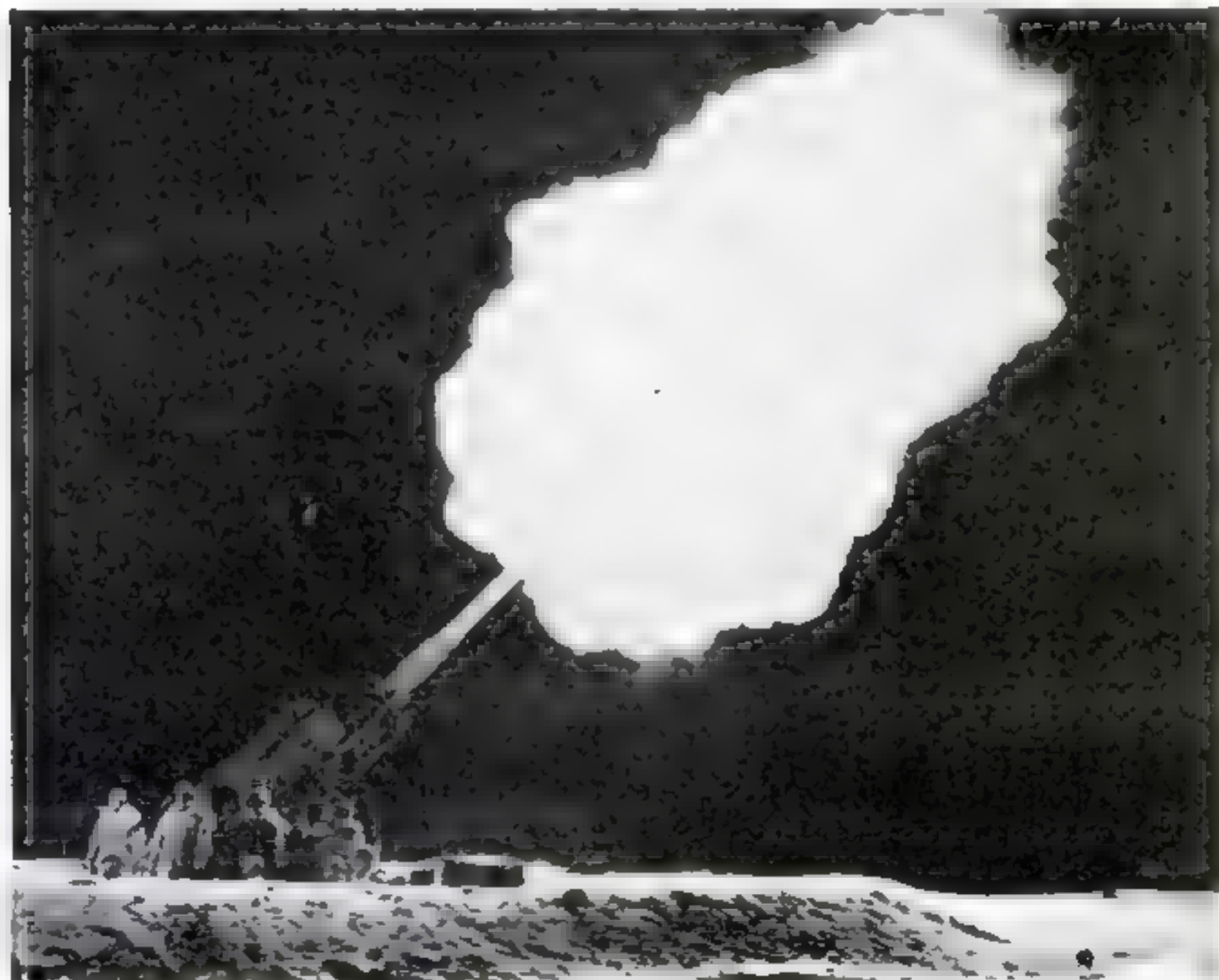
When American GI's and British Tommies streamed from their landing craft to storm the fortress-beaches of Normandy, the same kind of guns were unloaded within

a few hours to support the assault inland.

Big-caliber AA guns, so nearly automatic in their operation that their crews merely load the ammunition and pull the firing levers, are one of the brilliant developments of World War II. They are doing much toward the establishment of Allied air superiority on the battle fronts.

One gun of this type was only in the chrysalis stage at Pearl Harbor. Another had been produced only in small numbers and had to undergo refinement before it began shattering Axis aircraft at heights of

OUR BIGGEST AA GUN, the deadly 120-millimeter, bites the darkness with a huge white flare in night firing. Four of these can send 1 1/2 tons of steel and explosives up to 60,000 feet in 60 seconds.



ELEVATED TO 85°



THE 120 IS A DUAL-PURPOSE GUN

In spite of its near-automatic operation, the 120 needs a crew of 14 men. The 10 shown here are (A) kicker, who boots the empty cartridge off the loading platform; (B) sergeant in charge of the detail; (C) cartridge relayer; (D) cartridge loader; (E) cartridge handler; (F) projectile relayer; (G) projectile handler; (H) projectile loader; (I) gunner; (J) elevation tracker. The gun hides the azimuth tracker on the left side. Remainder of crew are additional cartridge and projectile handlers. The trackers have nothing to do if the gun is remotely controlled

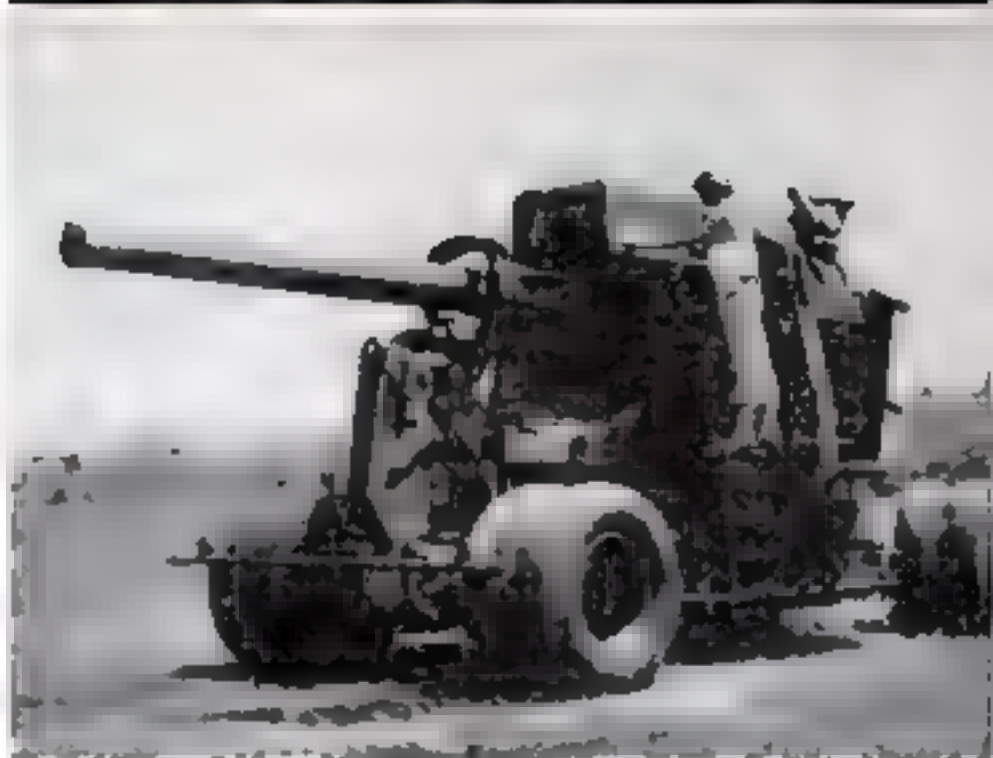
DEPRESSED TO -5°



six miles or more up in the substratosphere

Figures from the war fronts tell a fantastic story. In the North African campaign, AA gunners brought down more than 500 Axis warplanes. When the crippled H.M.S. *Illustrious* was in beleaguered Malta, ground gunners meeting one air attack on her destroyed 81 Stukas out of 300 in three minutes. In three months on the Anzio beach-head in Italy, AA gunners destroyed 349 enemy planes and accounted for 242 "prob-

TWENTY MINUTES AFTER IT



TRAVEL POSITION. On the road, the 120 is a compact parcel, though its 10 1/4-foot width doesn't leave much room for other traffic. Standard towing equipment for the 32 ton load is a 38-ton prime mover



3 Jacks, which have been submerged in the outriggers in transit, are raised to operating position and crewmen start pumping to lower the pedestal. The jack base is the one being unloaded in photo 1

6 With the third and fourth outriggers laid down, the loading platform is assembled in three sections. In addition to the outriggers, an octagonal spade under the pedestal gives stability in firing



STOPS ROLLING. THE GUN IS READY TO FIRE



1 When the piece arrives at the firing position, floats for the hydraulic jacks are let down on either side. Broad bases give high flotation to keep the jacks from sinking into the ground when the gun is 'pumped' down.



2 Now the first two of the four big outriggers are unfolded and laid flat. In transit, these are all doubled up and the front outrigger is secured to the cradle collar, the rear clamped to breech-ring sides.



4 In the meanwhile, a crewman has yanked the pintle pin that attached the drawbar of the prime mover to the axle of the front bogie. The prime mover commonly used carries the gun crew and a limited supply of ammunition.



5 Here the front bogie, with its four high flotation tires, is being rolled out. The gun is now so delicately balanced on its hydraulic jacks that it can be rocked with one hand. Bogie weighs two tons.

7 While all this was going on, crewmen have cranked the tube forward. Measuring 291 inches in length, the wicked-looking barrel retracts 70 inches for highway travel. Batteries are guarded by .50 caliber machine guns.

8 All that remains is to level the gun off with mechanical-type jacks. Only 20 minutes after it stopped rolling, the gun is ready to hurl its shells at the enemy high up in the air—or on the ground.





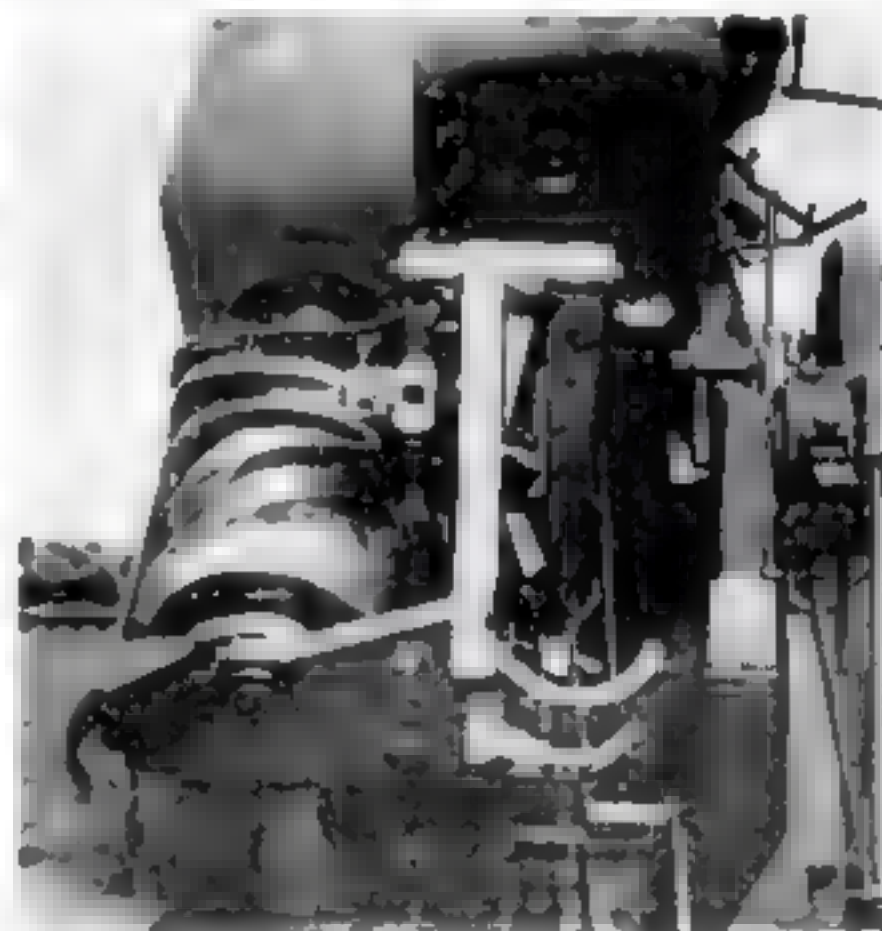
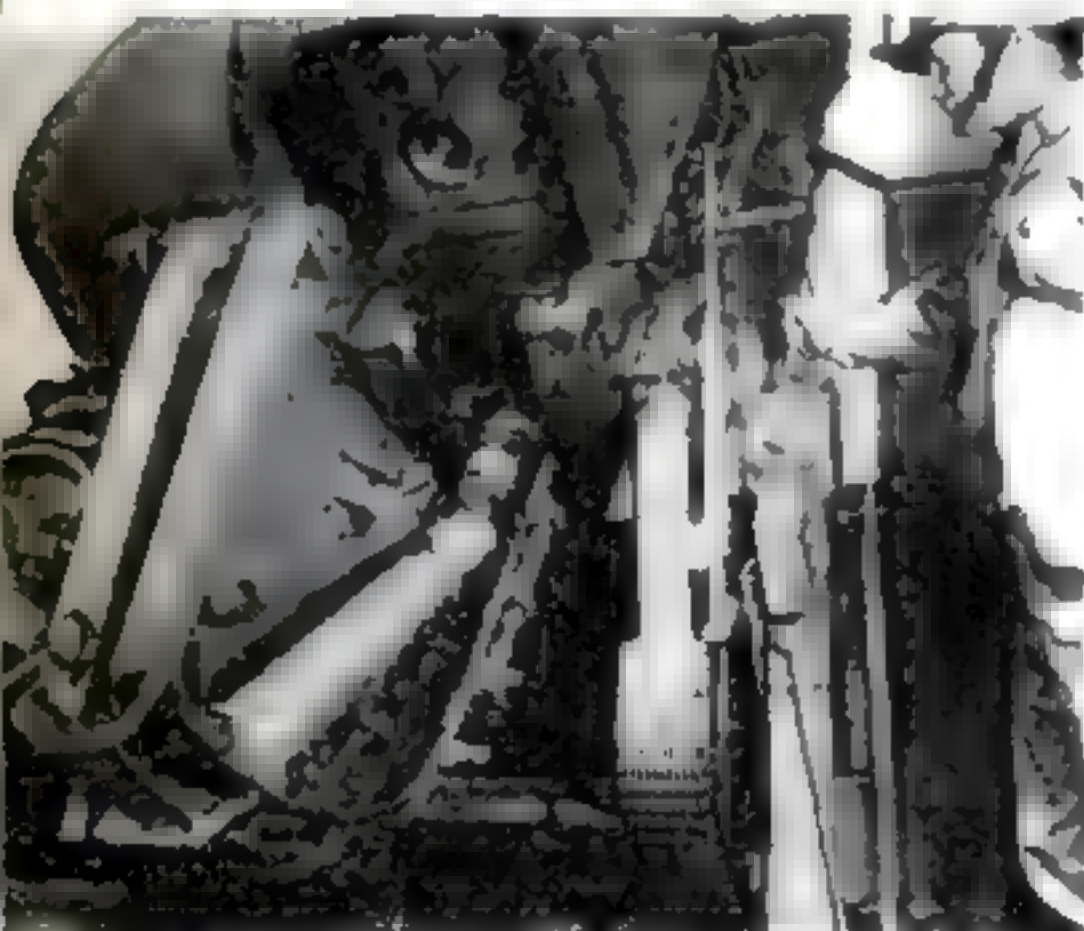
1 With the cartridge in the back end of the loading tray and the projectile snugged in ahead of it, the gunner starts the firing cycle by pulling the fuse lever. Butt end of projectile fits into the top of the cartridge case

3 Now the loading tray drops to the level of the breech. The automatic rammer shoves projectile and cartridge home. Here the gunner has his hand on the firing lever. The long handle beside it is manual breechblock opener



2 Like a snake's tongue, the automatic fuse setter darts back to engage slots in the snout of the shell. Governed automatically by the director, it times the explosion to match distance of target

4 The cartridge disappears into the breech. When the drop-type breechblock slips into position, the gun is ready to fire. A smart crew can get off 12 to 15 projectiles a minute at an enemy bomber



ables." Pretty soon the ground gunners were sitting around with nothing to shoot at. In some war theaters, one plane has been bagged for every 50 rounds of fire. Other theaters have reported one plane for every 90 rounds.

During World War I, Allied AA guns managed a hit—but not necessarily a kill—for every 17,000 rounds. In the next quarter of a century, the antiaircraft gun was hauled

into the laboratory, taken apart piece by piece, and studied. When it emerged, in time to get into World War II, it was a sophisticated weapon.

Its functions remained the same as those of its forebears: to destroy low-flying strafing planes and dive bombers; and to force medium- and high-level bombers to break off short of their target, make them miss, or bring them down.

Fundamentally the gun, too, remained the same. It was a tube and a breechblock, designed to deliver a projectile at a given time at a given altitude at a given point on a 360-degree circle.

But there the similarity ended. Ammunition had improved. Ballistics had been renovated. Prediction—the determination of where a target would be by the time a projectile had been hoisted to the proper altitude—had emerged from guesswork into scientific exactness. Automatic devices had reduced to a minimum the “dead time” between the apprehension of a target and the delivery of an explosive charge in its line of flight.

POPULAR SCIENCE MONTHLY has described in detail the functions of the small-caliber antiaircraft weapons used against targets flying at limited altitude. But airplanes flying very fast also can fly very high for bombing, air fighting, or reconnaissance, and here a much larger, more intricate weapon is needed to bring them down. The large-caliber AA gun is the weapon that stayed longest in the ordnance laboratory. It came out as a weapon of near-magic.

It is almost as automatic in its operation as a machine gun. It fingers space delicately to find its target and, finding it, pumps explosives as high as 11-plus miles at rates varying from 15 to 22 times a minute. The projectiles weigh from 25 to 50 pounds. Patterned in batteries of four, the largest of the American AA guns, throwing a shell measuring 120 millimeters (4.7 inches) in diameter, can deliver a ton and a half of steel and explosives at a height of 60,000 feet in 60 seconds.

The projectiles are aimed not into the area of the target but at the target, and therein lies the story of AA guns that went

to college. Happily enough, all the things that enable a gun to bring down an airplane began undergoing parallel refinement two decades ago.

A race was on. The airplane was flying faster and higher. Somewhere, sometime, the curve of antiaircraft efficiency and the curve of an aircraft's speed-altitude immunity from ground fire had to meet.

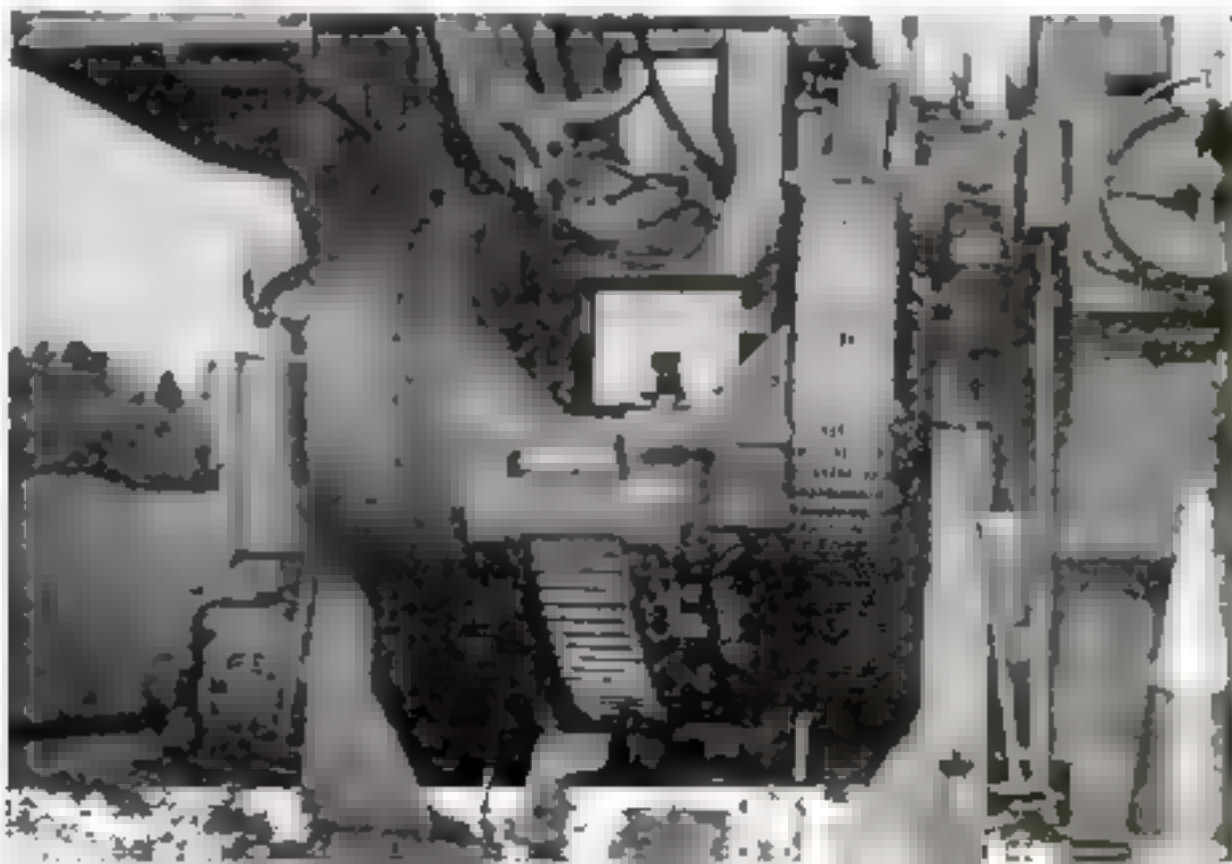
Before the war began in 1939, the U. S. Army was equipped with a three-inch AA gun. It was a good gun. In tests at Aberdeen Proving Ground it sprayed sleeve targets towed at 10,000 feet and above with commendable accuracy. It could deliver a projectile at an altitude of some 9,000 yards, but its effective range was somewhat below that. It was a good gun, but it was not good enough. The airplane, nursed along for years as an offensive weapon, flew too high and went too fast to be a good target.

This three-inch gun had horny-handed antecedents. In World War I it began as the famous 75-mm. artillery piece mounted on a circular track to give it traverse and modified to give it elevation. It had open sights. It had no fire-control system. By 1923 Army Ordnance produced a three-inch AA gun of approximately the same range that could be elevated to within five degrees of the vertical. It was progressively refined in the ensuing years. The fuse on its projectile could be timed more accurately and the explosive charge was more homogeneous and gave a more stable explosion pattern.

As early as March, 1940, a 90-mm. (3.54 inch) AA weapon had been standardized (P.S.M., May '43, p. 66). It was not yet in mass production. At the same time, another, bigger gun firing a 120-mm. shell was in the design stage. *(Continued on page 206)*

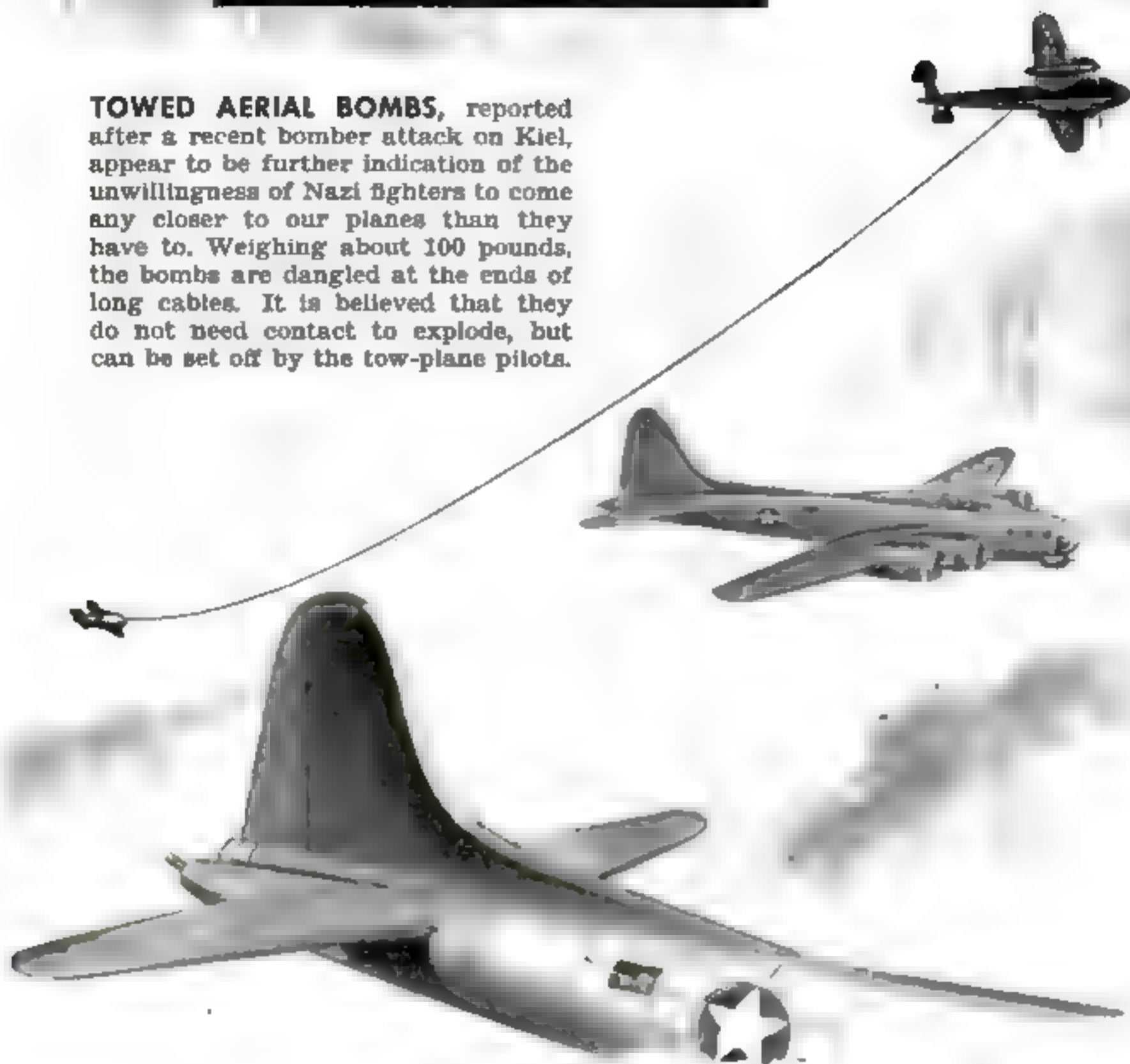
RECOIL is handled by three cylinders under the tube. Middle one is filled with oil, two outer ones with nitrogen gas that acts as a spring to return the tube

EQUILIBRATOR CHAINS keep the tube in balance, regardless of elevation. They pull on pistons in cylinders situated on either side of a surge tank filled with oil and nitrogen gas. Practically all of the long tube's weight rests forward of the trunnion, the pivot point that supports the tube and its cradle



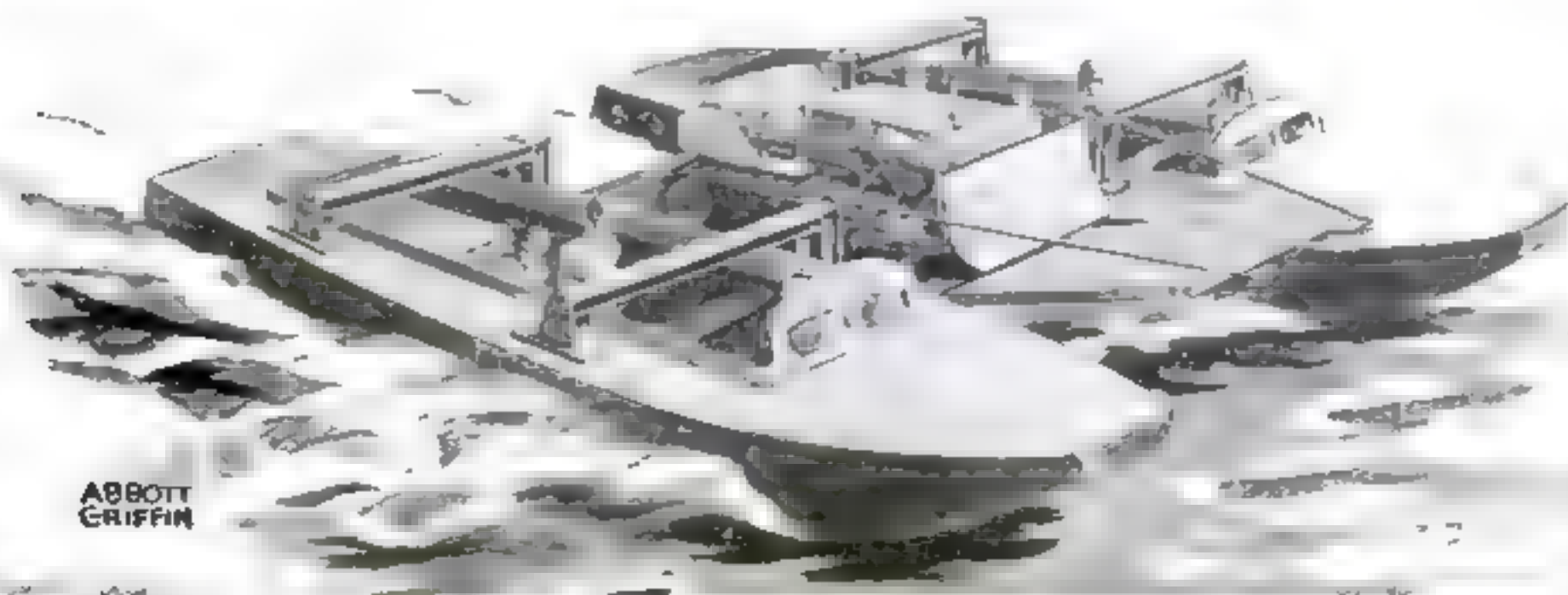
war ideas

TOWED AERIAL BOMBS, reported after a recent bomber attack on Kiel, appear to be further indication of the unwillingness of Nazi fighters to come any closer to our planes than they have to. Weighing about 100 pounds, the bombs are dangled at the ends of long cables. It is believed that they do not need contact to explode, but can be set off by the tow-plane pilots.



TWO-BOAT TRANSPORTATION for such equipment as tanks, field-artillery pieces, and bulldozers has been suggested by Andrew J. Higgins, famed New Orleans boat builder, as the best way to move this material from our cargo vessels to invasion beachheads. The boats, of the shallow-

draft ponton type, are connected by a platform that acts as the carriage for the equipment. Attached to the front of the carriage is a hinged section, which, when raised, would serve as an impromptu bow; when lowered, it could be used as a ramp for landing equipment on a beach.



HAVE YOU ANY GOOD WAR IDEAS?

Your country needs and wants inventive ideas. You may help to hasten victory and thus save the lives of thousands of American soldiers by suggesting a new device or an improvement on an old one. Do not send your suggestions to this magazine. Send them to National Inventors Council, Department of Commerce, Washington, D. C.

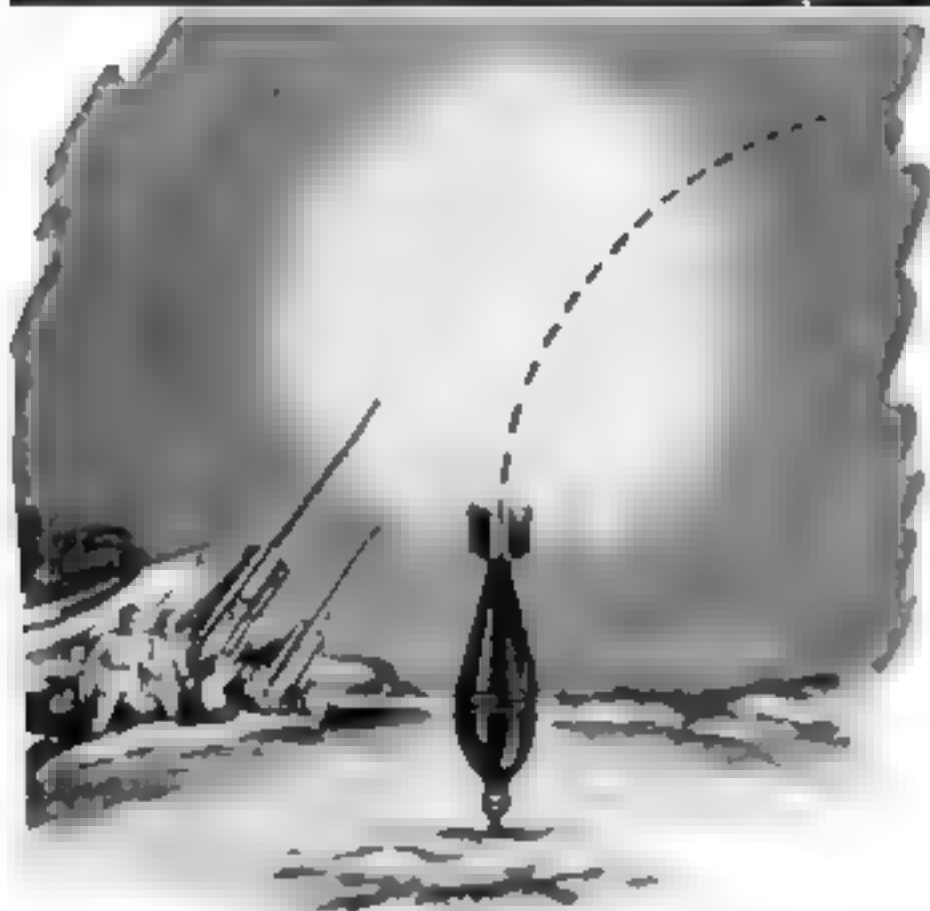
CIVILIANS invented the airplane, the submarine, the machine gun, and scores of other weapons that win wars. Our armed forces need more such ideas from more Americans now. Our officers are looking, for instance, for ways to protect our troops from enemy flame throwers. Have you any suggestions?

Ingenious and simple decoy devices are needed, to confuse and mislead the enemy. So is an optical device that will enable our men to distinguish quickly between the natural green of vegetation and artificial green coloring. A gas mask that would permit the wearer's voice to be clearly heard is also in demand.

The National Inventors Council has a staff of experts to evaluate ideas of all sorts and refer them to the proper military authorities. All ideas received will be held confidential. Accepted ones may be patented for the inventor, without expense to him.



PROTECTION for our soldiers against enemy flame throwers is one of the up-to-now unsolved problems of this war. If you have any ideas on the subject, the National Inventors Council will be glad to consider them



GROUND FLARE. A phosphorus-filled mortar shell that helps to "brighten things up" for enemy troops attempting to hide under the cover of darkness is the novel invention of an American infantry officer, Capt. Gerald H. Shea. Having the tear-drop shape and flight-steadying tail fins of most mortar shells, the projectile also carries an ignition fuse at its base. Through the body runs a sharp-pointed sliding rod. As the projectile hits the ground, the rod digs in sufficiently to hold it erect and at the same time slides part way back into the mortar to set off the ignition fuse. The use of these flares enables small infantry groups to illuminate enemy positions without aid from supporting planes.

TORPEDO JOCKEY.

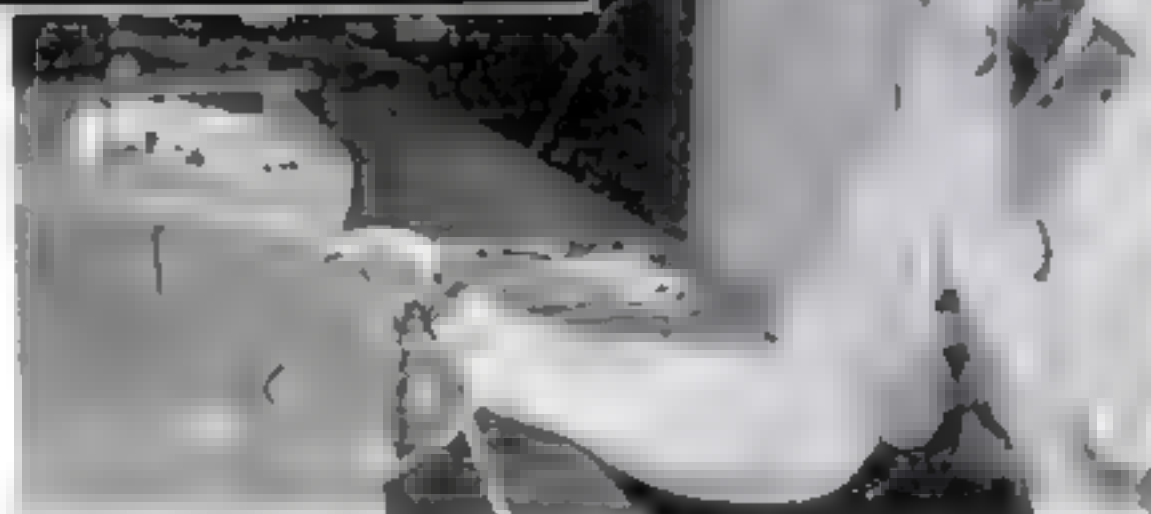
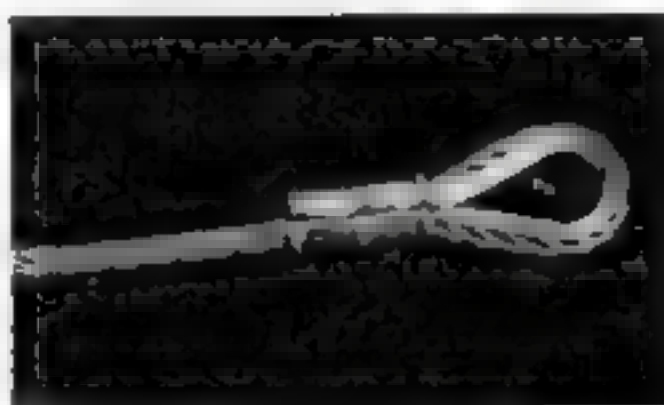
This German one-man sub, similar to the two-man weapon made famous by the British, was recently captured when it came a cropper on an Anzio beachhead held by our troops. As shown in our artist's conception, the torpedo is slung under the sub. It can be quickly released on approach to the target, the sub and its rider then heading for safety.



new Tools

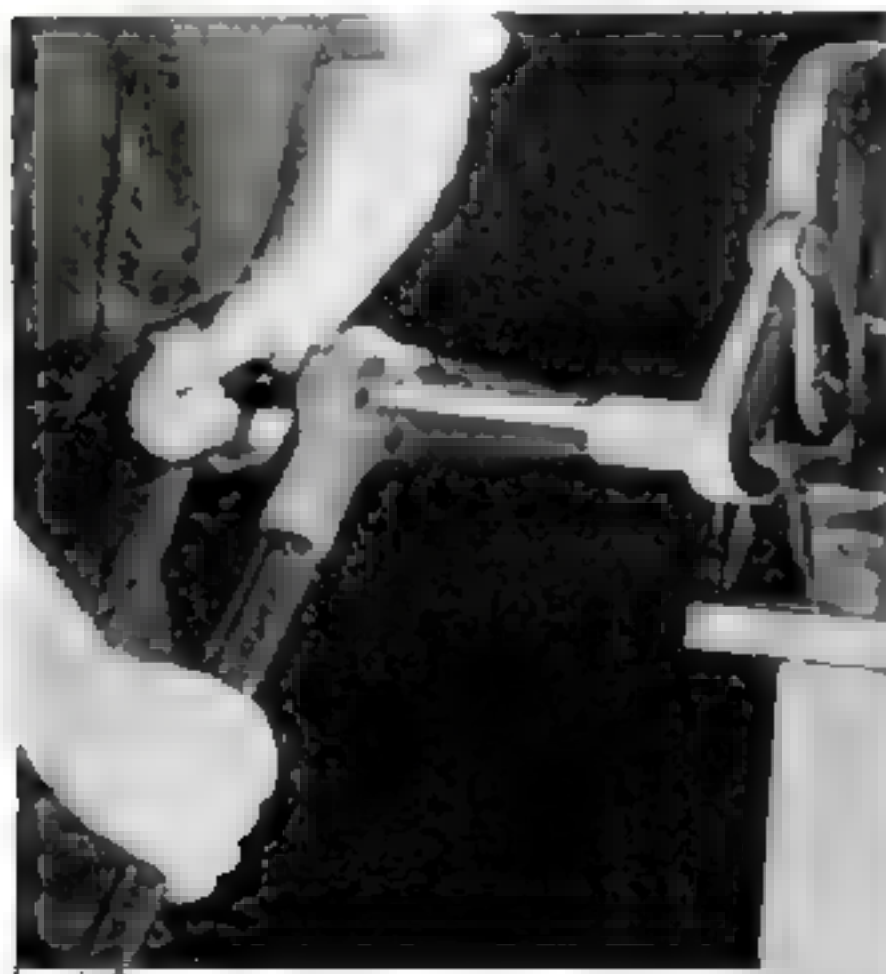
DANGEROUS FUMES from welding operations no longer mean sick leave for workers. A mask has been devised with a compressed-air unit that fits under the welder's hood, circulating a continuous stream of air in the area around the nose and mouth. Sweating is prevented, and also soiling of the eyes. Pullman-Standard Car Manufacturing Co., Chicago, are the makers.

EXTRA MAN-HOURS—over 250 a week—are added to production by Glenn L. Martin Co., Baltimore, Md., with a new copper sleeve for splicing cable and making eye loops. In the latter process, cable is fed through the oval-shaped sleeve, looped around a thimble, and brought back through the sleeve. It is crimped with a hand-operated, pliers-principle tool and a foot-operated set of dies. Brittle material on the sleeve's interior breaks up under this action, bites into the cable, and makes a stranglehold bond in a fraction of the time formerly required.



THERE'S NO BURR in pipes and conduits tooled with this reamer having an extra-long taper. The gradual diminishing guards against splitting, flaring, and wall reduction. The Ridge Tool Co., Elyria, Ohio, make the tool and the ratchet handle that goes with it.

THREE WRENCHES IN ONE are available to users of the new Tesco multi-socket wrench, which, by its pressure over any size nut to which it is adapted, automatically selects the proper hexagonal tube required. It is made by The Eastern Specialty Co., Philadelphia.



Come with Me on My "Jeepmarine"



Submarine holidays are made possible by a peacetime adaptation of the British "torpedo built for two."

By **WALTER NUNN O'BONDIE**

Lieutenant, R.N.V.R.

EVERYBODY seems to be thinking of flying for fun after the war. Many Americans apparently hope to swap their flivvers for helicopters and spend their spare time dangling from the sky, munching hot dogs

bought at a convenient blimp filling station.

But not for me! My wife and I are going to spend our week ends touring the bottom of the sea on our jeepmarine. We plan to explore caves and grottoes on the ocean floor. We'll park our tandem underwater motorbike on the barnacled deck of some ancient wreck, and search for doubloons and

pieces of eight. When time permits, we'll ship our jeepmarine to tropic seas and go riding through coral groves, dismounting occasionally to look for pearls. At least, we'll be sure to return with a handsome bath sponge of our own plucking.

Such fancies are a diversion from the grim, dirty job of waging war. But my dream has substance; it is far more realizable than the hope of the demobilized pilot to go flitting through the clouds with his ladylove. The initial cost and upkeep of my "submarine built for two" will be much less than that of a flying machine. It will be less dangerous to operate, and I won't be bothered so much by rules and regulations.

Little serious thought has been given to the peacetime possibilities, for sport and industrial use, of the "human-torpedo" craft designed to attack enemy ships and harbor installations. But I know of two men now assigned to one of these new naval weapons—one is a hairdresser in civil life and the other a dry cleaner—who hope to buy a decommissioned jeepmarine from the government after the war and use it to explore the Spanish Main for galleon gold.

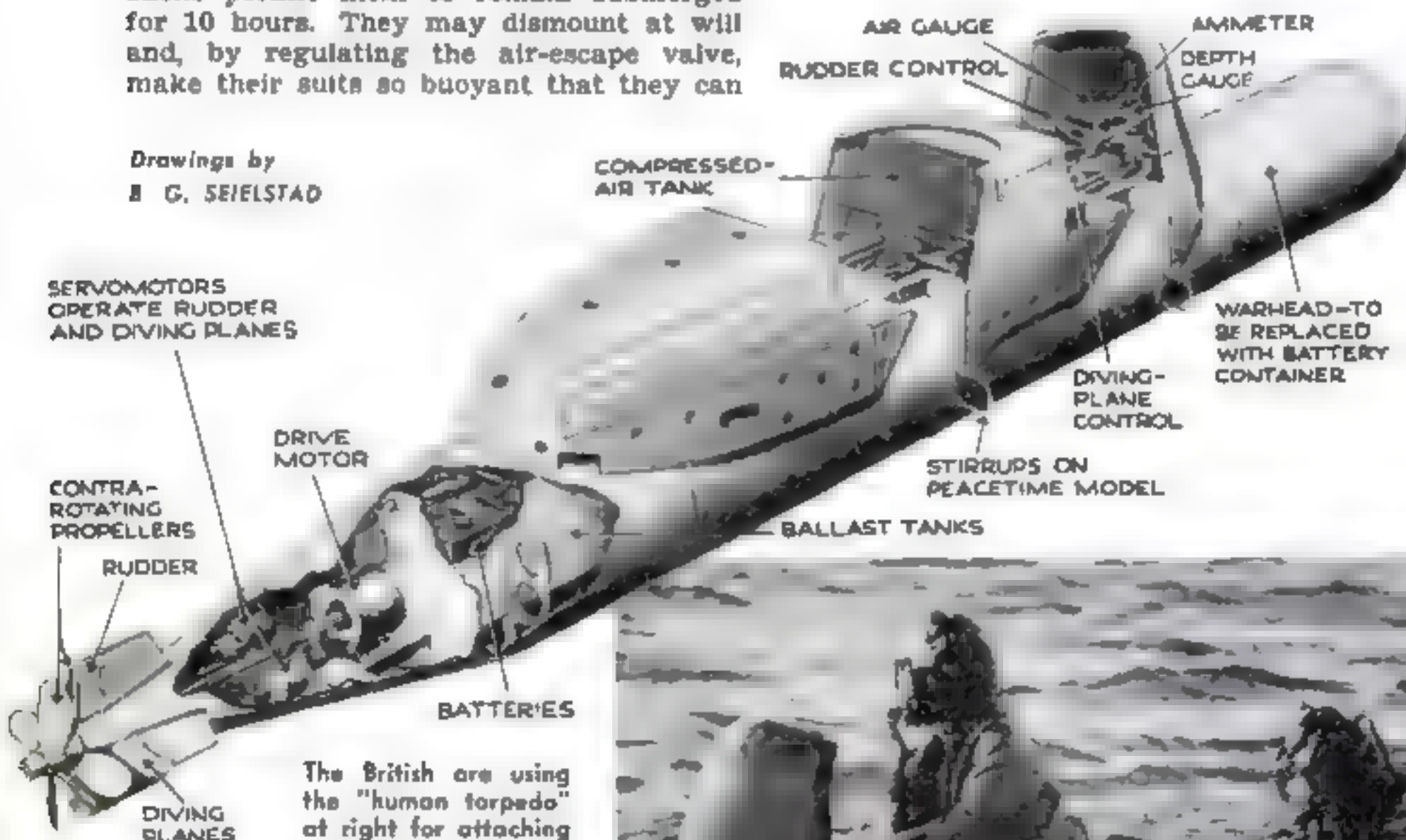
The submarine motorbike has a cylindrical chassis 21 feet long. Two persons sit astride it behind conventional-looking motorcycle windscreens. They wear diving suits that weigh less than 50 pounds, and their hands are left bare. Each person can dress himself for undersea cycling in less than five minutes. Oxygen tanks carried on their backs permit them to remain submerged for 10 hours. They may dismount at will and, by regulating the air-escape valve, make their suits so buoyant that they can

float like fish at any level. Deflating their suits permits them to walk, with their lead-soled boots keeping them vertical.

The jeepmarine is powered by storage batteries. It can cruise on the surface or dive to any bearable depth, then level off and proceed in any direction. Contra-rotating propellers nullify torque; one propeller is mounted on a hollow shaft revolving around the solid shaft of the other, both driven through a simple gear box. The craft is steered by means of vertical rudders, the same as any small boat; it dives and ascends by use of port and starboard hydroplanes or fins. Movement in all four directions—up, down, left, or right—is controlled with a single steering apparatus similar to the stick of an airplane. The present submerged speed is only a little faster than a brisk walk, and the cruising range is about 10 miles. The range could be increased by adding more storage batteries in place of the explosives that the "human torpedo" is built to carry.

Candidates for wartime jeepmarining assignments must pass rigid physical and psychological examinations. But when the hazards of war are removed, any able-bodied person should be capable of operating one of these submarine motorbikes. You will not even be disturbed by your wife's comments from the rear seat; there is no means of oral communication between persons in separate diving suits.

Drawings by
B. G. SEIELSTAD



The British are using the "human torpedo" at right for attaching explosive charges to the hulls of enemy vessels. The author of this article foresees a post-war role for it as an undersea pleasure car



Resin-emulsion paint comes in paste form. You simply mix it with 50 percent of tap water, and you have an oil paint that covers almost any surface with only one coat, dries in an hour, and presents an oil-film surface that is easily washable

Oil and Water Mix In Resin Paints

CHEMICAL "undercover agents"—ingredients unsuspected by users—make possible the new resin-emulsion paints that are thinned with tap water, flow smoothly, dry rapidly, and leave a durable film that compares with that of oil paints. Since most resin-emulsion paints consist of suspensions of tiny globules of oil and resin in water, they must contain an emulsifying agent that will envelop each particle of oil in a thin coating to prevent its joining its oil neigh-

bors. To keep the emulsion stable over a long period, some colloidal material such as clay or casein is mixed with it. Another anonymous ingredient designated as a "wetting agent" is added so that water may be mixed with the hard-to-wet pigment, and a further agent prevents bubbles from forming. No less than 15 different ingredients go into the Du Pont Speed-Easy paint of this kind. The illustrations below show how these "undercover agents" work.

HOW RESIN-EMULSION PAINTS WORK

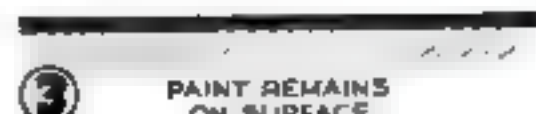
The trick was to find a way to hold oil particles suspended in water so that the paint could be applied smoothly and the water content would evaporate, leaving the pigment clinging firmly to the surface after one application.



① WATER AND OIL PARTICLES APPLIED TO SURFACE



② WATER EVAPORATES, AND IS ABSORBED



③ PAINT REMAINS ON SURFACE

EMULSIFYING. Oil paint and water won't mix in beaker at left. Add an emulsifying agent and shake; oil droplets are suspended



WETTING. Many pigments, too, refuse to mingle with water. Pigment floating at left sinks when the wetting agent is added



Hurry up your entry in our \$5,000 Contest

for the best letters on

"The Plane You'd Like to Own"

You have until September 30 to write a letter
and try for one of the many War Bond awards

IF YOU hope to win a \$1,000 War Bond or any of the many other prizes offered in our \$5,000 contest on "The Plane You'd Like to Own," you had better hurry up. The contest ends on September 30, and your entry must be in the mails on or before that date.

Why don't you sit down right now to write a letter of not more than 1,000 words telling as clearly as possible what sort of private plane you would like to own in the approaching air age? It will be fun to figure out just what features and conveniences should be incorporated in postwar private planes. Maybe your idea or combination of ideas will place you among the big prize winners.

Before you prepare your entry, be sure to read very carefully every word of the official rules. These have been published three times—on page 114 of the June issue; page 108, July; and page 122, August.

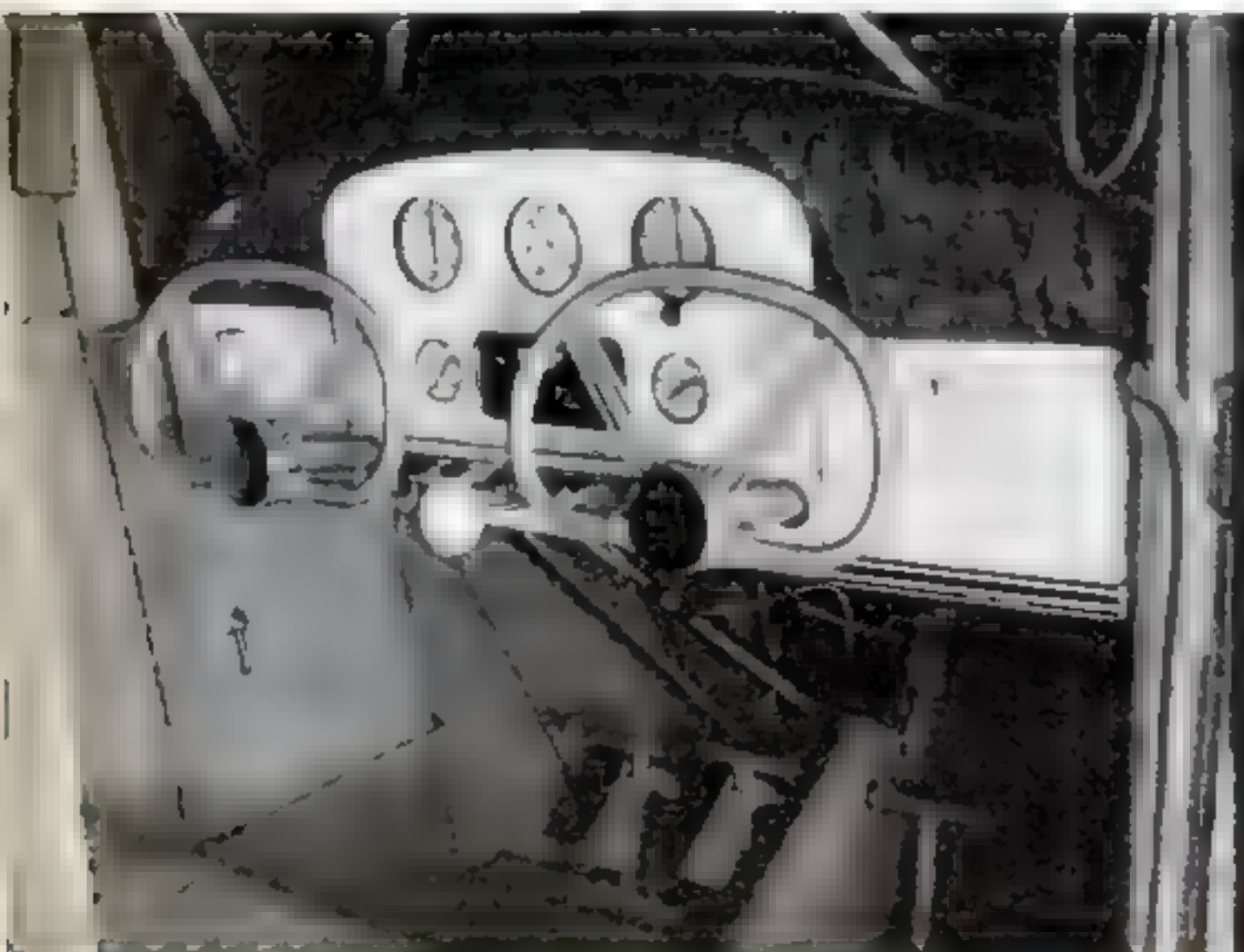
It will also pay you to study the drawings, lists, and suggestions contained in the contest articles in those three issues. If you do not have copies, try to borrow them or consult them at your public library. Such well-known aviation illustrators as Eric Sloane, Douglas Rolfe, and Stewart Rouse have shown in full color the types of planes they themselves would like to own. In the three articles, too, there were many drawings and photographs to help you in visualizing a good light-plane design.

You may enter either the nonprofessional class, which is for general readers without any special technical knowledge of airplane design and construction, or the professional class, which is for those with training in aviation engineering, aircraft design, or aircraft drafting.

If you are a nonprofessional, you have merely to write a letter, although you may include sketches or plans if you wish. However, if you are entering the professional class, you should not only write a letter but also prepare a drawing that shows the front, top, and side views of the type of

Aeronca Super Chief has carefully styled accessories. Instrument panel contains only essential flight and engine instruments. Seating arrangement and control wheel virtually duplicate similar equipment to be found on a well-appointed modern coupe

POPULAR SCIENCE





Wheel pants add to effectiveness of performance of Aeronca Super Chief in flight. This 65-hp. prewar light design, with steerable tail wheel and brakes for better handling on ground, has good stability. Plane has cabin heater, ventilation for passenger comfort

AWARDS TOTAL \$5,000 IN TWO SEPARATE CLASSES

PROFESSIONAL

For Aviation Engineers, Designers,
Draftsmen

FIRST PRIZE . . .	\$1,000 War Bond
SECOND PRIZE . . .	500 War Bond
THIRD PRIZE	300 in War Bonds
FOURTH PRIZE . . .	200 in War Bonds
FIFTH PRIZE	100 War Bond
SIXTH PRIZE.	50 War Bond
SEVENTH to TWENTIETH PRIZES	
\$25 War Bond each .	350 in War Bonds

NONPROFESSIONAL

For
General Readers

FIRST PRIZE . . .	\$1,000 War Bond
SECOND PRIZE . . .	500 War Bond
THIRD PRIZE	300 in War Bonds
FOURTH PRIZE . . .	200 in War Bonds
FIFTH PRIZE	100 War Bond
SIXTH PRIZE.	50 War Bond
SEVENTH to TWENTIETH PRIZES	
\$25 War Bond each .	350 in War Bonds

plane you prefer. If you wish to make additional sketches, that is your privilege, but they are not required.

The judges (see P.S.M., July '44, p. 109) will select the winners on the basis of ideas alone. You don't have to make your entry look pretty. All the judges want is sound thinking, original ideas, and a clearly ex-

pressed letter that tells exactly what you would like in your own plane.

Don't delay. If you make any drawings, please don't fold or roll them; keep them flat. Mail your entry to Plane Contest Editor, Popular Science Monthly, 353 Fourth Avenue, New York 10, N. Y., not later than September 30.

The entire wing of the Waterman Arrowbile lifts off the top of the fuselage, and may be stored while the craft is being used as an automobile. Plane is tailless, and the engine and propeller are in the rear



ELECTRONICS PROMISES

How Factory Production Is Being Made More and More Automatic

YOUR life after the war is going to be affected by electronics in many ways. The great impact will come, not through any one spectacular development, but through the expanding uses of electronics in industry. Why? Because the production of countless necessities of life—houses, autos, machinery, tools, will be immeasurably speeded up and improved.

The extraordinary strides made by electronics in war production have pointed the way. We now know how to control manufacturing operations with superhu-

man accuracy, how to assemble materials with amazingly precise methods of welding, and how to run motors at infinitely varying speeds to suit each changing phase of machine operation. And we can do much of it automatically.

As Carl Dreher outlines the wonders of industrial electronics in this article, they give marvelous promise for the future. But they also present a great—perhaps an even greater—challenge because of the extent to which electronic controls may replace skilled workers.

PART III OF A SERIES ON ELECTRONICS AFTER THE WAR

By CARL DREHER



Westinghouse

THE MASS SPECTROGRAPH. Using centrifugal force to separate a substance's gas molecules and their constituent atoms, this weird-looking analyzing machine can detect one part in 100,000 of a material under observation

THE variety of functions of which electronics is capable, in industrial applications alone, could not be described in anything short of an encyclopedia. All we can do here is to glance at a few things electronics can do better than they were done before, and others which, without electronics, could not be done at all.

When, less than two centuries ago, James Watt began working on his steam engine, he was at first unable to obtain a round piston that would fit snugly inside a cylinder. With the machining methods then in use, there might be spaces of a quarter of an inch through which the steam could escape. Nowadays, machine parts are commonly made with a tolerance of less than a ten-thousandth of an inch. Length, thickness, speed, time, mass, illumination, chemical composition, electrical quantities—are all measured with an accuracy of only a few parts in a million, and usually you find electronic or semielectronic devices doing the measuring.

An example of a wholly electronic measuring instrument is the cathode-ray oscillograph. Called "the

NEW MIRACLES IN INDUSTRY

by Amazingly Accurate Methods of Measurement and Control

most versatile measuring instrument ever devised by science," it has been used in industry for not much over 10 years. The operating principle of the cathode-ray tube is the deflection of an electron beam by electrodes in the neck of the tube, to which an unknown variable voltage is applied. Functioning as a weightless pointer, the beam traces a curve on a fluorescent screen, which shows how the voltage varies with time.

In industry, the cathode-ray oscillograph will reveal exactly what is happening inside a radio transmitter or receiver. It will draw a picture showing how lightning affects a transmission line, an alternator, or a circuit breaker. The magnitude and duration of welding currents, the behavior of electronic mo-

tor controls, and of every other electronic or electrical machine, can be studied in the utmost detail. By using some form of pick-up to convert mechanical into electrical energy, the vibrations of machines, engines, musical instruments, and timepieces may be analyzed. Metals may be tested for composition and characteristics by observing their

Allen B. Du Mont Laboratories, Inc.

THE CATHODE-RAY OSCILLOGRAPH.

Considered the most versatile of all measuring devices, this wholly electronic instrument can do such jobs as analyze vibration, test a metal for its characteristics, show the effect of lightning on a circuit breaker

A PHOTOELECTRIC CELL scans a strip of tin plate as it races past at 1,000 feet a minute. The light source used is immediately above the strip. By detecting holes even smaller than 1/64 of an inch, the "eye" protects canned foods from spoilage and leakage

Westinghouse



magnetic or electrical behavior when subjected to high-frequency fields.

When the middle-aged engineers of today were at college, the usual method of measuring the speed of a rotating machine was to stick a mechanical tachometer or revolution counter against the end of the shaft. In the case of a very small motor, the tachometer load might be enough to slow it down. With high-speed machines, the method was likely to be inaccurate because of slippage. By means of an electronic straboscope—a light flashing at a known frequency—the speed of a rotating object may be measured accurately without contact.

Electronic measurements may deal with quantities inappreciable except by almost incredibly sensitive instruments, or as great as the distance of a star from the earth. They may soar out into space—or burrow into the earth. In scientific exploration for oil, dynamite is exploded in a shot hole, setting up a small artificial earthquake. Suitably disposed pickups, designed to convert earth vibrations into electrical vibrations, respond to the reflections from the underlying rock strata. The outputs of the pickups are amplified electronically and recorded as seismograph traces, which permit mapping substrata as deep as 20,000 feet.

The new technique of resistance welding requires electronic control. The process consists in joining metal parts by pressing them together mechanically, sending an electric

current through the joint, then shutting off the current and maintaining the pressure for another instant while the molten metal "freezes." It sounds simple; the catch is that the number of amperes sent through the weld, and the length of time the current flows, must be precisely controlled. When a welding engineer specifies that a given number of amperes of 60-cycle current are to be sent through the metal for, say, a quarter of a second, he doesn't mean 14 or 16 cycles, he means exactly 15 cycles. Any deviation may mean the difference between a perfect weld and a poor one. Some types of precision resistance welding are actually done in a fraction of a cycle, and it has to be the same fraction each time, in the same part of the cycle.

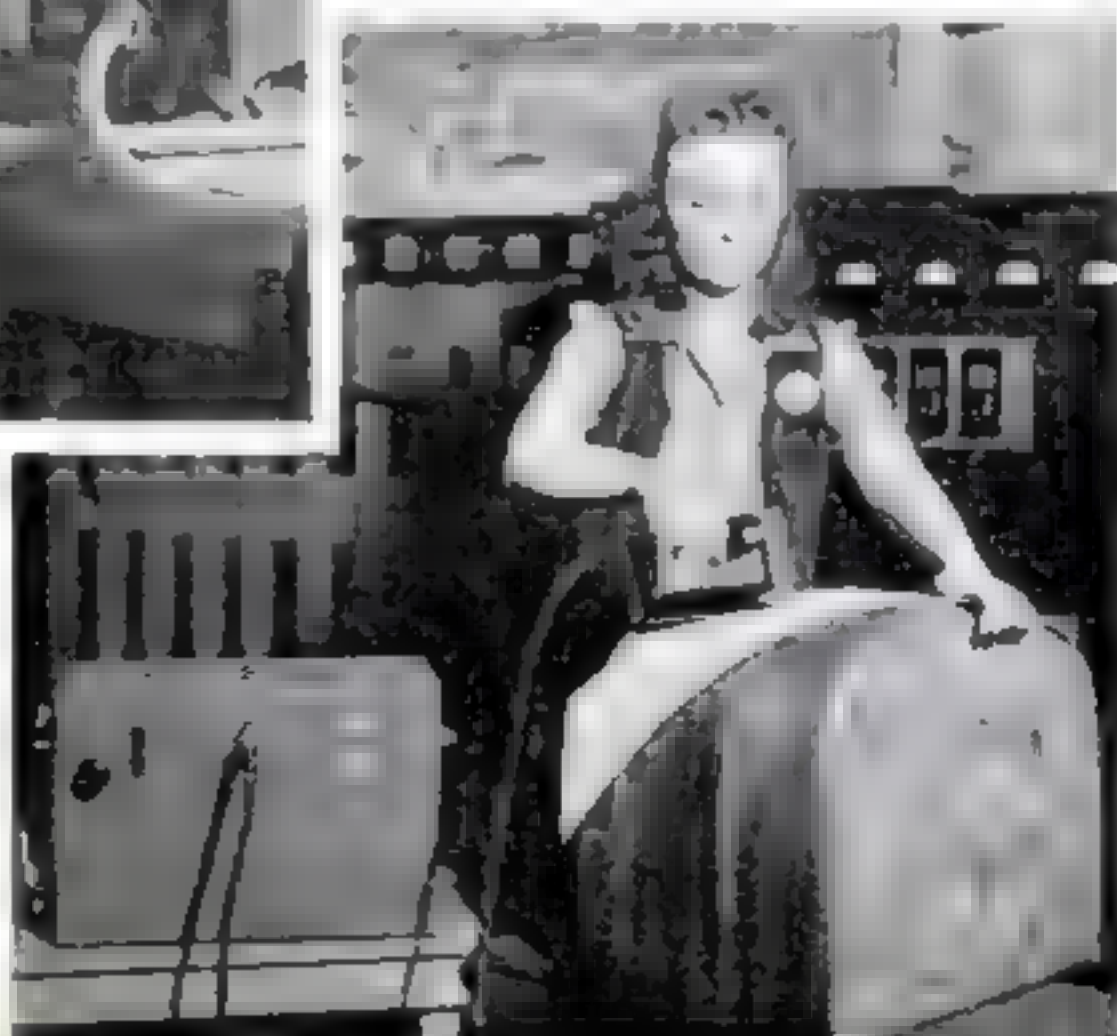
Welding even thin sheet steel calls for currents of several thousand amperes. For large parts, welding currents may be in the vicinity of 50,000 amperes. These currents are produced by a step-down transformer, but even the primary current of such a transformer will run to several thousand amperes. Making and breaking currents of this magnitude is a ticklish job, and it has to be done automatically hundreds of times a minute. About the only kind of switch that measures up to the job is a frictionless and inertialess device in which small amounts of power can control large amounts—in short, an electronic device.

Resistance welding with electronic con-



"RADIO TACKS." Another RCA product—one brought out experimentally—is an electronic machine (right) for temporarily bonding thin veneers of wood while they are cut and shaped into plywood forms. The applicator shoots high-frequency current through the top veneer, joining it to the veneer below by forming, at each point of application, a bond in the glue previously put between the veneers

ELECTRONIC DETONATORS designed by RCA are speeding airplane construction with a bang. Emitting high-frequency radio waves, they set off the small dynamite charges in the explosive rivets developed by Du Pont. W. M. Roberts, RCA engineer, is shown (at left) demonstrating the detonator



trol, applied on a commercial scale, is now well over 10 years old. The war, plus the inherent reliability, speed, and economy of this type of welding, has given it a powerful impetus. Already over 10 percent of the rivets used in airplane manufacture have been replaced by spot welds. Ultimately there may be a 100 percent change-over in this field. This is only one application of resistance welding; gasoline tanks, automotive parts, refrigerators, and vacuum tubes are others.

Induction heating, a comparatively new method of applying heat in industrial operations, has also contributed materially to war manufacturing, and promises to play a significant part in postwar electronics. By older methods, heat is caused to flow into the material from the outside, so that the surface gets hot first and may be overheated before the inside is even warm. With electronic methods, heat may be produced within the material, so that, if desired the whole mass can be kept at a uniform temperature throughout the process. Or, with equal ease, electronic heat may be applied selectively. By using a small radio-frequency coil, for instance, it is possible to harden the slotted end of a setscrew to a depth of 1/10 inch, leaving the rest of the screw soft so that it will make a gastight seal. Gears or crankshafts, for example, may be surface-hardened without causing internal brittleness. A smooth coating of tin

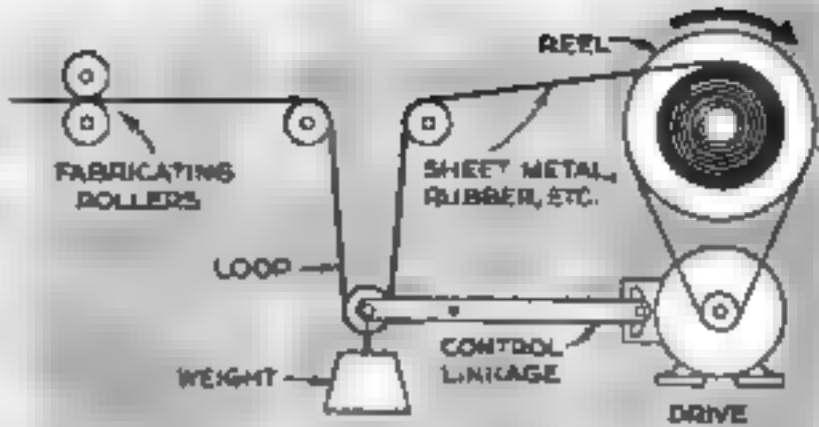


Fig. 1 MECHANICAL FEEDBACK

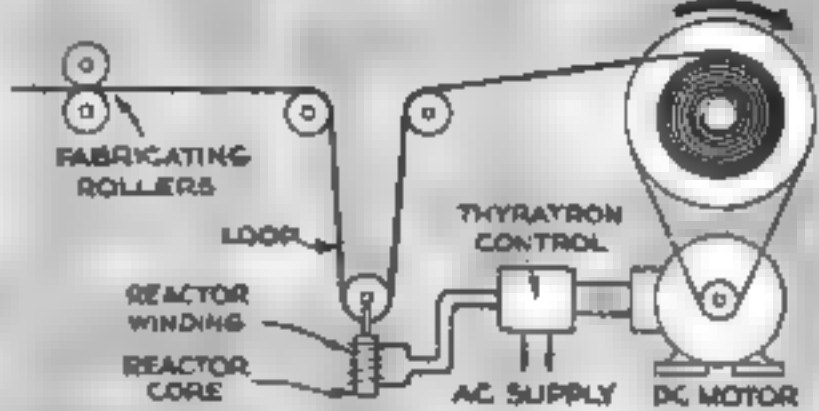


Fig. 2 REACTOR-THYRATRON CONTROL

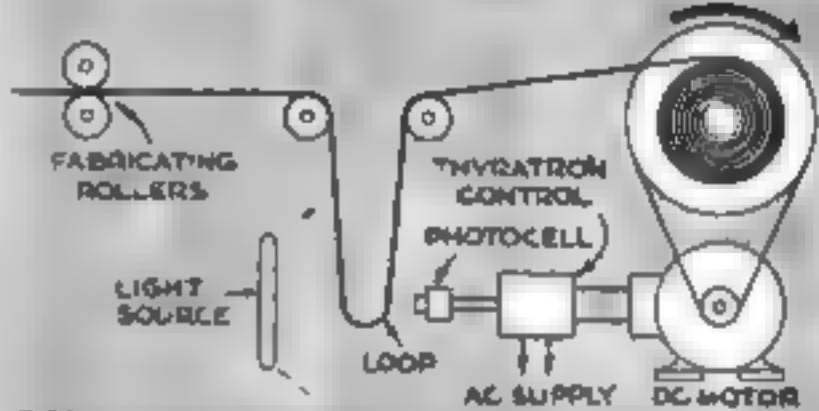
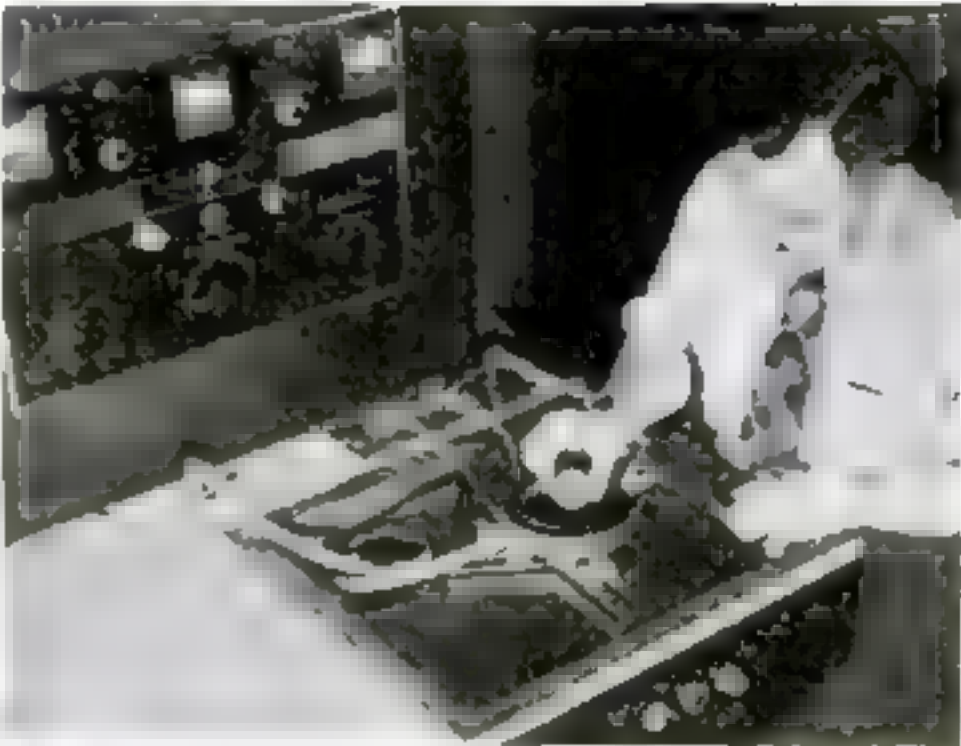
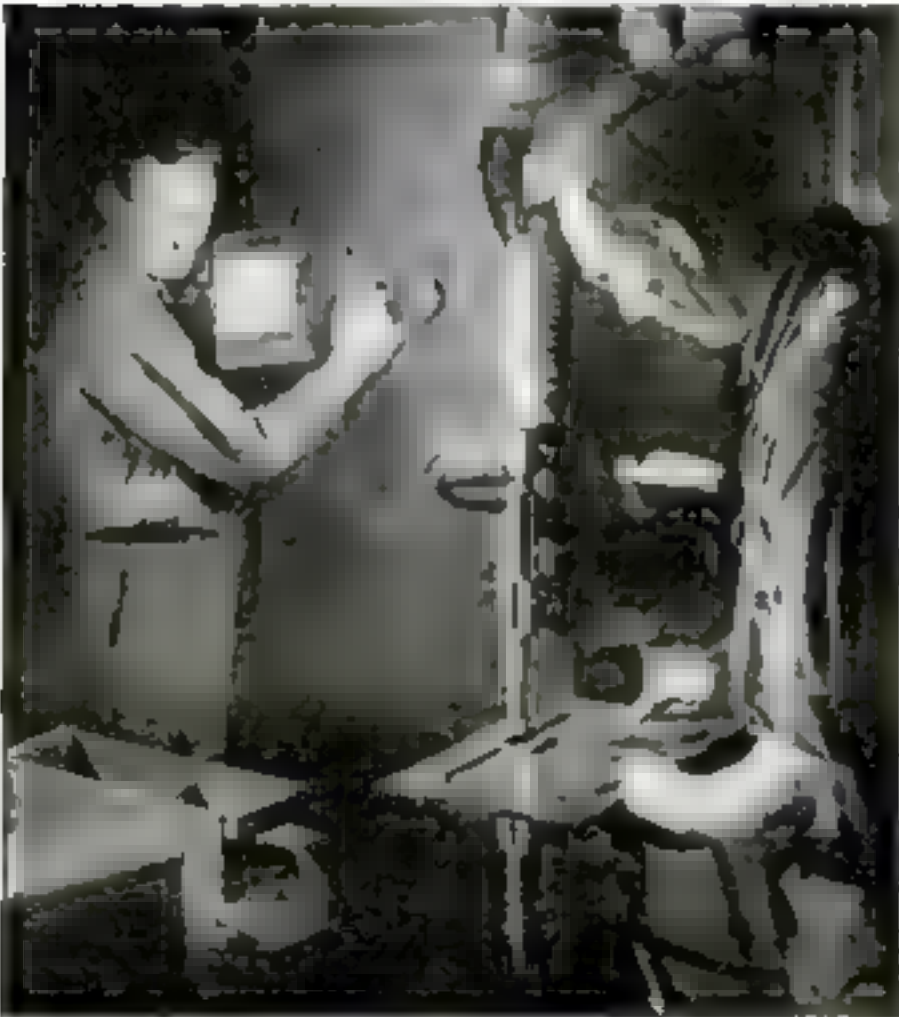
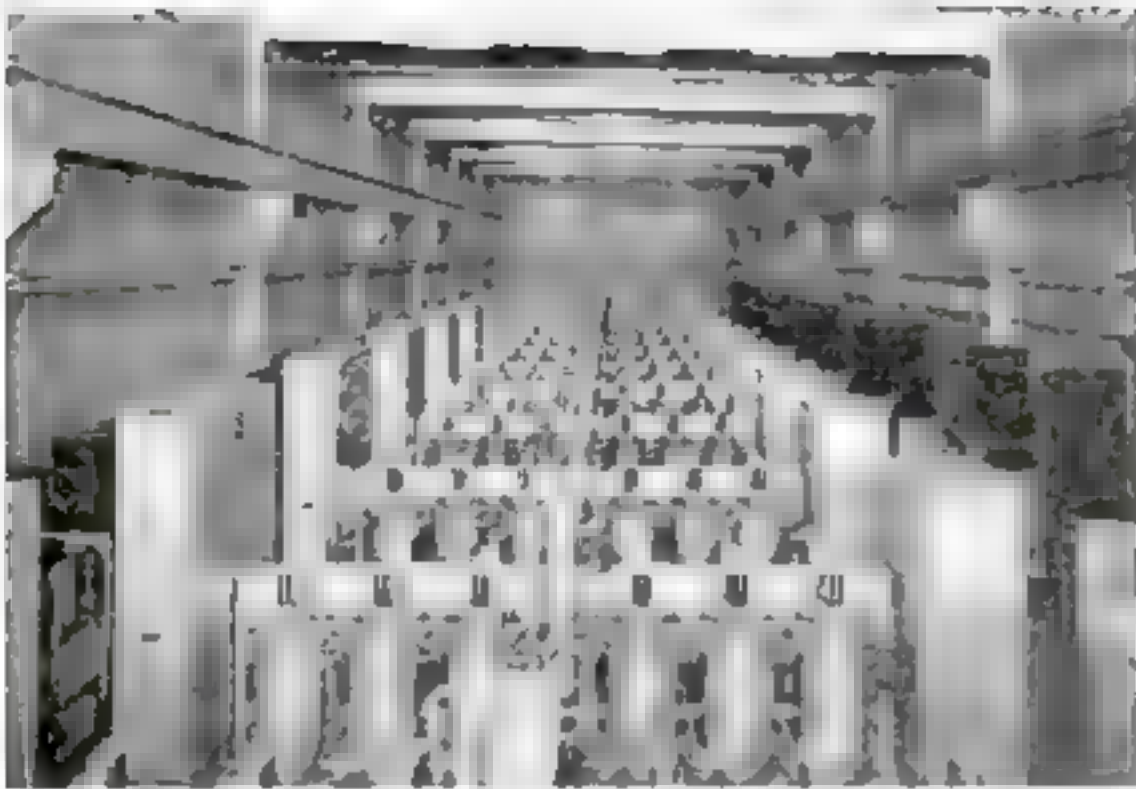


Fig. 3 PHOTOCELL-THYRATRON CONTROL

ELECTRONIC HEATING has one great advantage: it can be "beamed" to a restricted area. Because of this it has proved invaluable in such work as hardening the surface of a material without causing any internal brittleness. At the right, an operator prepares to harden the surface of a small gear with a General Electric 15-kilowatt heater



RESISTANCE WELDING, to be done well, needs the delicate hand of electronic control. Essentially the welding consists of joining metal parts, applying high-ampere current to the joint, and then holding the parts in place until the molten metal "freezes." The trick, however, is to apply just the right ampere (which can be precisely controlled with a thyatron) for just the right length of time (which can be regulated with an ignitron). Left, spot-welding two metal pieces with 48,000 amperes. Here the ignitron is measuring off exactly eight cycles



General Electric

CONVERTING ALTERNATING CURRENT to the DC needed in the electrolytic production of metals is done at one plant with this big 12-unit Ignitron mercury-arc rectifier installation

only 30 millionths of an inch thick may be electroplated on sheet steel heated inductively to a temperature of 450 degrees F. Many similar applications will be found in which electronic heating results in a better product.

There are two general types of induction heating: electromagnetic and electrostatic. If the material is a good conductor, it may be placed in or near a coil of wire in which alternating current is flowing. The electromagnetic lines of force cut the material, inducing eddy currents that release heat. In other words, we make the material to be heated the secondary of a transformer and

the secondary is also the load. If the material is a poor conductor or an insulator, we place it in the electric field between two metal plates connected to a radio-frequency oscillator. The material then becomes the dielectric element of a condenser or capacitor, and is heated by dielectric losses.

Electrostatic heating requires high frequencies; its present band is 500 kilocycles to 50 megacycles. Up to about 12,000 cycles, alternating-current generators are the usual power source, but in the kilocycle and megacycle ranges, vacuum-tube oscillators and, to some extent, spark gaps are employed. The process is then truly electronic and the name *radiothermics* is sometimes applied to it. (P.S.M., May '43, p. 58.)

A comparatively recent application of electrostatic heating is in the quick curing, or drying, of the glue and plastic adhesives in bonding plywood such as is used in airplane propellers. It is also important in the plastics industry. The preform, or piece to be molded, may be heated electronically so that when it reaches the molding press it is uniformly hot and plastic inside and out. In the electronic "sewing machine," thermoplastic sheeting, such as is used in raincoats and packaging, may be joined by application of heat to soften the material and form a seam (Continued on page 208)



General Electric

LIGHT BEAM of a photoelectric unit is used here to hold the edge of a steel strip in alignment as the strip winds up on a drum. A variation of a few thousandths of an inch will start a corrective action

X RAYS check the powder content of these detonating fuses as they move past on a traveling belt. An improper amount of powder will be instantly detected and announced by an alarm, thus enabling workers to remedy the condition

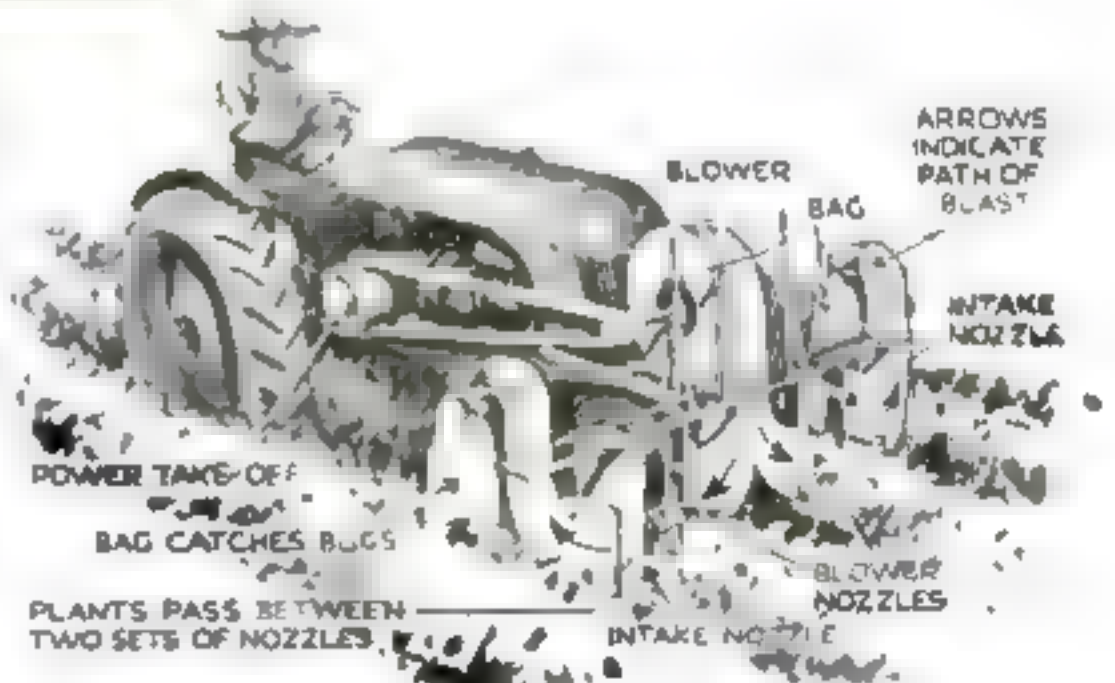
General Electric



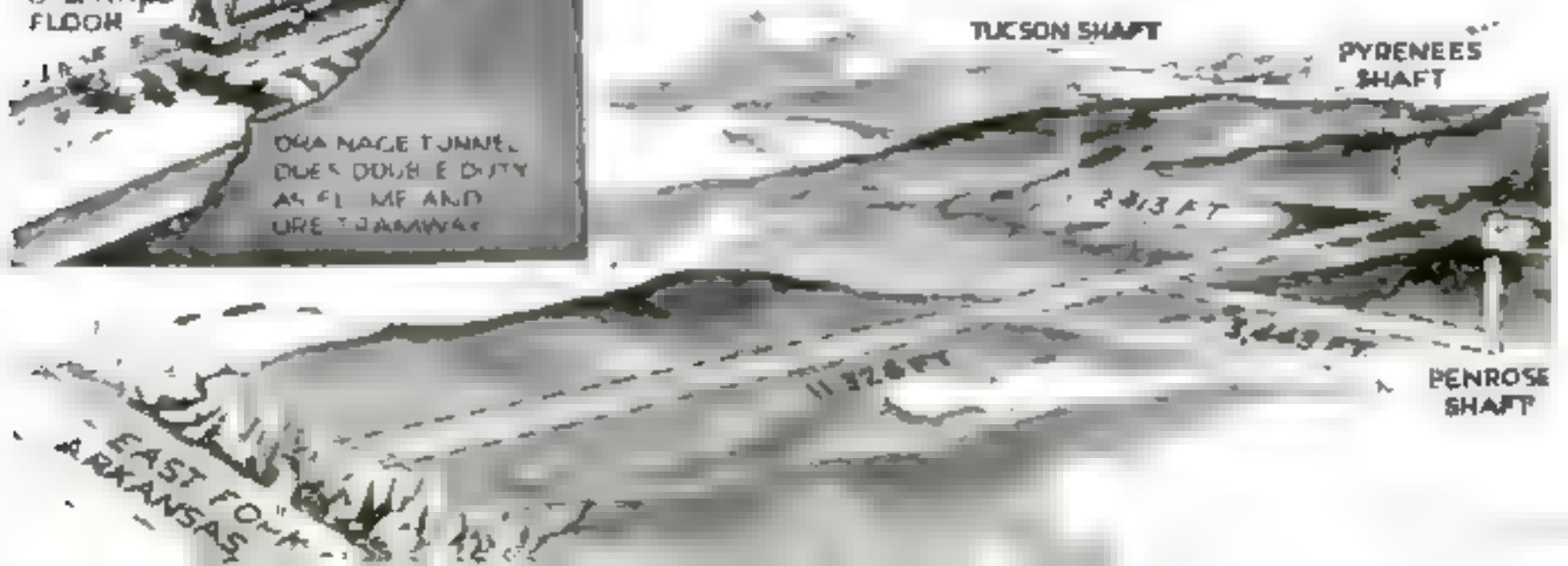


BLIMPS GO AFTER FISH -finny as well as tin. Mindful of the necessity of a continuing sea-food supply, the U. S. Navy is co-operating with the Office of the Co-ordinator of Fisheries by having its sub-hunting blimps shortwave the location of schools of fish to interested vessels in the area. Patrolling blimps easily spot quarry that fishermen operating on the surface of the water might miss or take hours to locate.

BUGS CAN'T STAY on farm crops when this insect collector is put into operation. Designed to combat the boll weevil, the machine also removes other bugs from two rows of plants at once. A fan assembly on the front of a tractor delivers a blast of air through pipes leading toward the rows. The bugs are blown off the plants and driven through funnels into disposal sacks. A. R. Nisbet, Plainview, Tex., is the inventor and manufacturer of the new machine.



UNWATERING MINES at Leadville, Colo., will release an estimated 200 million dollars in zinc and lead ore. A 17,000-foot tunnel will be built by the U. S. Bureau of Mines, and through the tube, 10 feet high and 9½ feet wide, nine million gallons of water will be carried daily to the Arkansas River. Tracks may be built over the flume to provide for ore haulage, as shown in the drawing by B. G. Seielstad.



Picturing Water with Your Camera

BY FLORENCE C. O'CONNOR

UNLESS you live on a desert, there are probably several kinds of water within photographing distance: brooks, rivers, lakes, ponds, canals, and even the ocean. Moving water, still water, fresh water, salt water, clean and dirty water, quarries and city wading pools—all have pictorial possibilities. Pictures that depend on water for their main accent know no season. No special equipment is necessary beyond the usual filters, lens shade, and tripod, if you use one. There is one caution: check on local Army and Navy restrictions before attempting to take waterfront scenes in areas of wartime activity.

The quality of water that distinguishes it most, at least pictorially, is its wetness. In order to keep it from looking solid, avoid tones that are too dark, for transparency is indicated in the print by careful control of tonal values. Water itself is almost colorless, reflecting the color of the sky and its surroundings. A K1 or K2 filter may be helpful especially in strong sunlight, but darker filters are not recommended.

As water pictures are apt to show extreme contrasts, particular attention should be paid to getting the exposure as nearly correct as possible. Subsequent care in retaining values when making the print will give the water in your picture a feeling of reality.

"Freezing" the motion of water is a danger engendered by the fast lens. However useful an $f/2$ lens may be in sports or action photography, it has no use, opened wide with the shutter set at $1/250$ or $1/500$ second, for water pictures. Under ordinary light conditions, a shutter speed of $1/100$ second is fast enough for the most turbulent waterfalls and breakers. At a faster speed, the water will appear static, resembling glass more than water. Fast-moving water looks blurred in nature, and it must also look that way in the picture.

If a mysterious streak of light appears on your print, it is probably a reflection from the sun that was not obvious when you made the exposure. A sun shade over the lens will save you a retouching job.

Water and reflections are usually synony-



Surf, Ogunquit



Waterfall

mous to the amateur. Good reflection pictures, however, are hard to make, principally because the tendency is to make them too good. The reflection should never be so perfect as to cause anyone to take it for the real thing. Make the picture on a day when there is some movement in the water or when the atmosphere is not crystal clear. Soft, diffused reflections suggesting, not showing, what is mirrored are

the most successful. Avoid a cluttered look. A water-soaked log and floating scraps can be shoved out of camera range easier than they can be removed from a print.

Try not to tell two stories. Trim off the top of a reflection picture, allowing just enough to indicate what is being reflected. A test is to cover the top of the picture until all distracting elements have been eliminated. [Turn the page.]



Pickerelweed

Edges of ponds and lakes usually have interesting weeds and aquatic plants that fairly shout to be made into Chinese pattern pictures. It may be necessary to wade in, as a carefully arranged close-up composition is necessary since the picture will lack subject interest. "Pickerelweed" has a feeling of placidity of a hot summer day. Note how light in tone the water was kept, since it reflected a light-blue summer sky. If nature hasn't provided ripples enough to give the picture interest, toss a small stone in the picture area and utilize the concentric circles.

No stiller waters exist than salt marshes, those fascinating backwaters of the sea that run inland for miles. As they are often pretty shallow, take them at high tide and feature the reeds and grasses on their banks. Sometimes an anchored rowboat adds a focal point of interest, as in "Salt Marsh."

Surf pictures are the bugaboo of all photographers. Their

fascination tempts you to use roll after roll of film, but success is in the lap of the gods. All you can do is to pick a good spot and try to anticipate the break of the wave. If the wind is high, be sure to protect your camera from salt spray, which is apt to rust it and also tends to fog the lens. "Surf, Ogunquit" was made on the rugged shore of Maine.

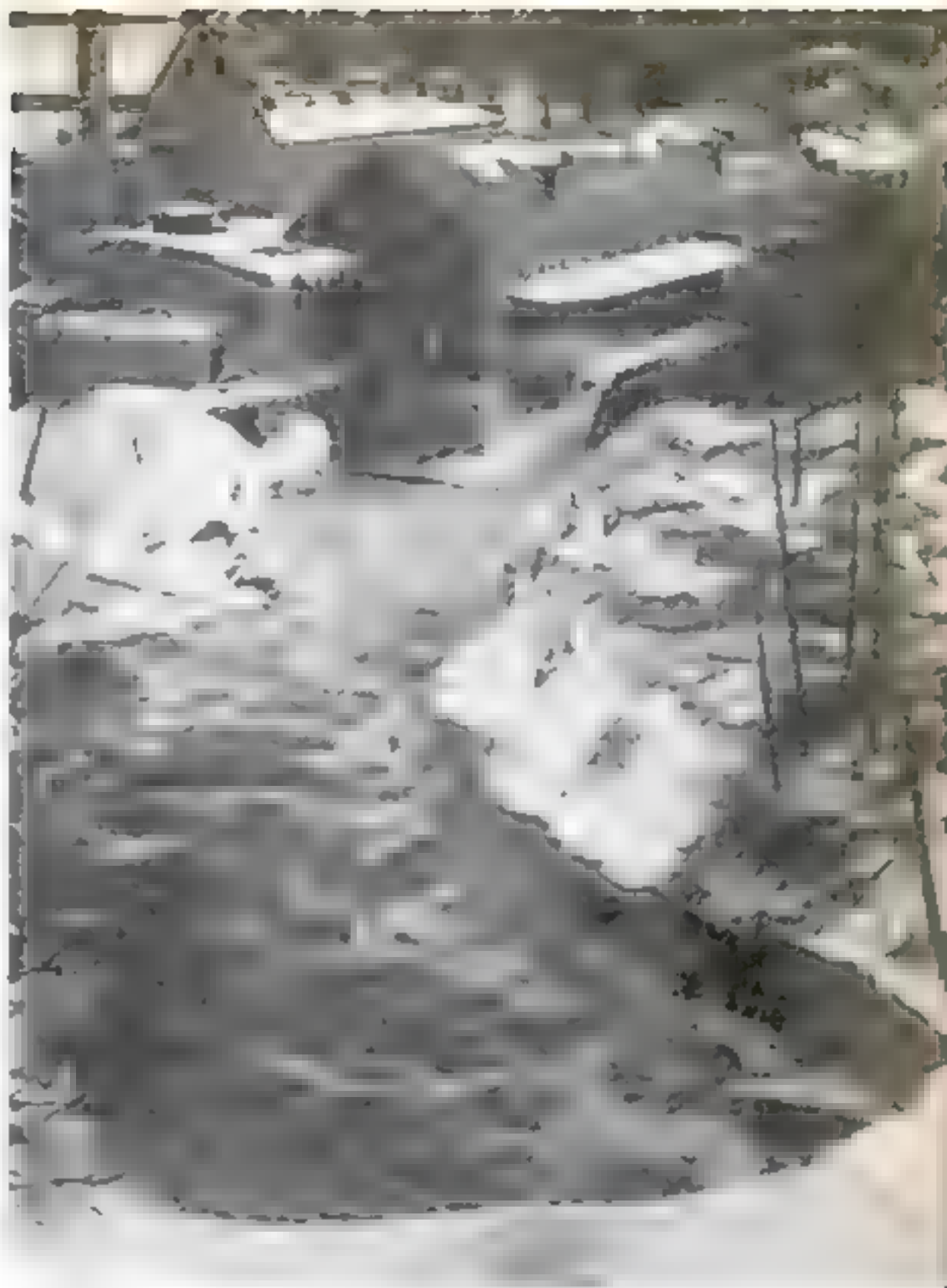
Pictures made on a beach can show interesting curves formed by the foam on



the sand as it rolls up and recedes. This makes good pattern pictures. A beach is one place where the detail cannot be overdone, so stop down the lens and show every bubble. Beach pictures showing a wide sweep of open ocean are often helped by including an immense sky. This gives the feeling of grandeur and infinity associated with the sea.

Falling water is fascinating—its every movement different. The translucency of clear water running over hard rock is a natural for the pictorial picture. A pattern picture can be made using only the edge of a dam, as in "waterfall," or an entire fall may be used. If a pattern picture is made, it is almost necessary to use a strong diagonal line in order to give the picture force. In winter, floating snow and ice may vary the pattern. Winter water always looks darker than summer water, unless snow-covered banks are reflected.

If more than a part of a fall is to be shown, the print should be vertical to add to the feeling of height. Showing some of the surroundings, but not enough



Mill on the Dam



to detract from the fall, adds interest. Concentrate, however, on the fall. In "Waterfall," the dark-toned woods and brilliant sunshine filtering through help accent the crystal quality of the water.

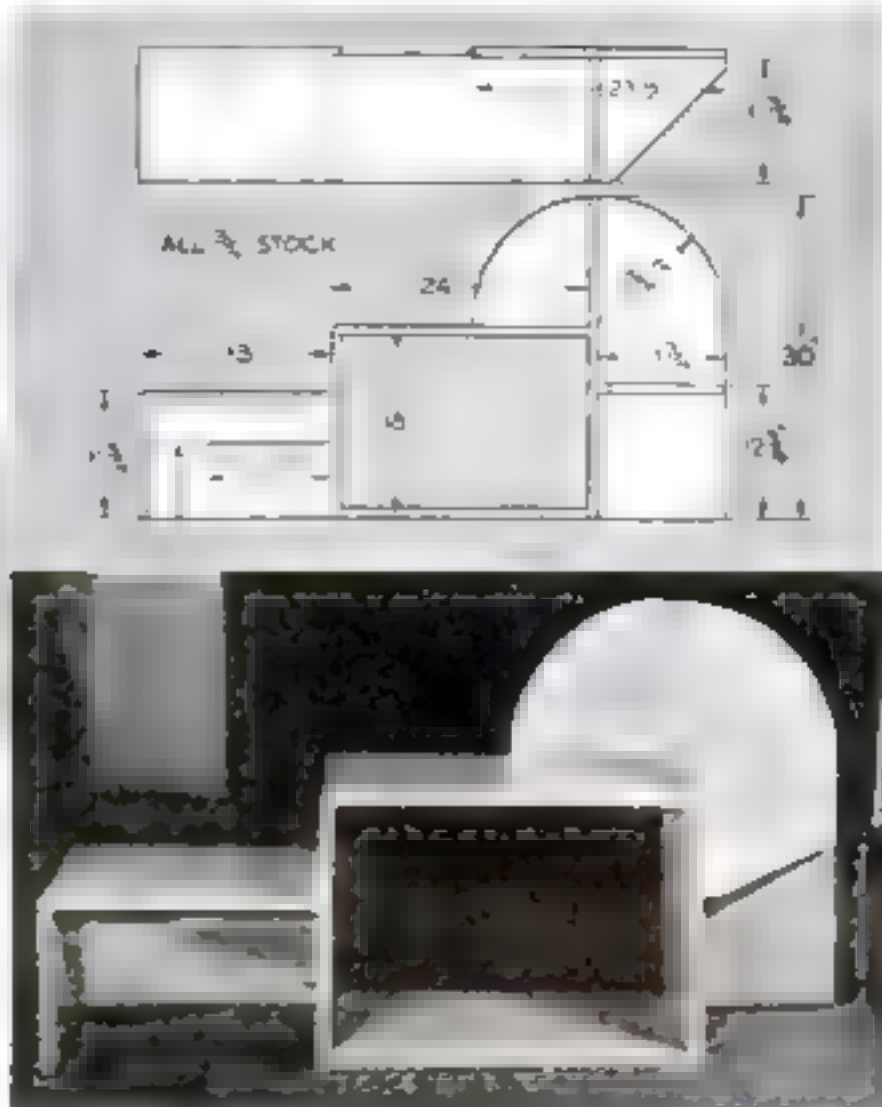
There is nothing like a snow-banked brook to give you a wonderful S-curve, the good old Hogarth line of beauty. The success of "Winter Song" depends on this form strengthened by the vertical line of the reflected tree. Winter water scenes show extreme contrast, and "soot and whitewash" prints are neither true nor beautiful. Snow is not white, but blue, or yellow if taken in late afternoon, and water not black, but the color of the snow and the sky. The resulting print, therefore, while it will have some deep tones such as reflected trees, will be mostly light in value. A scene of this sort has an extremely long tone range and should be printed on a projection paper with a long scale of contrast, say a chloro-bromide.

Industrial scenes can often be made more effective by showing the motive power of the mills. "Mill on the Dam" depends for its vitality on the force of the river as it surges toward the mills.



CHILDREN POSE NATURALLY, and adults, too, when aided by a posing bench made like the one shown at the right. The small triangular seat is attractive to small children, while babies unable to sit alone can be propped safely on the upper level. An adult seated on the lower level and a child on the upper make an effective picture, or a child seated on the lower level may use the upper as a table for toys. In the photo at left, the subject supports her hand on one of the circular uprights.

If a power saw is not available for making the quadrants on these uprights, mark



them with a compass; then saw successive tangents, taking care not to cut within the line, and use a rasp and sandpaper to round the corners. Any finish is unobtrusive in black-and-white photos; washable pastel colors are suitable for color film.—J. W. C.

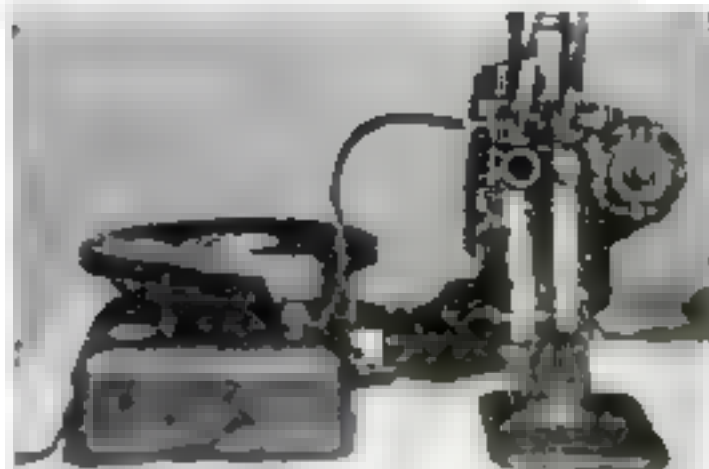
SHUTTER SPEEDS can be checked easily by photographing at different speeds a strip of adhesive tape on an old phonograph record. Since phonograph turntables are regulated to revolve at a constant speed of 78 r.p.m., the tape will move 468 deg. per second, or 93.6 deg. in 1/5 second, 18.72 deg. in 1/25 second, 9.36 deg. in 1/50 second, and 4.68 deg. in 1/100 second. Make test photographs from directly above the revolving record, and check the results with a protractor. When a shutter is found not to operate at the speeds indicated, corrections can be made by adjusting the diaphragm.—W. E. LANG.



TWO ENLARGEMENTS of different sizes can be made from each of a set of negatives without racking the enlarger up and down every time by providing a box of suitable dimensions to bring the smaller paper closer to the lens. In place, as shown at the left, the box serves as a base for the smaller enlargement, while the larger is made on the regular base. The only adjustment between exposures is refocusing the enlarger lens.—L. H.

FOG ON OUTDATED PAPER can be removed by a modification of Kodak R-4 Farmer's reducer. Make one solution of 1 oz. water and 5 grains potassium ferricyanide, and another of 16 oz. water and 150 grains hypo (sodium thiosulphate). Mix them together just before using. After fixing the print, rinse it in water, and then immerse it in the reducer for five to 10 seconds. Stop the action by agitating the print in clear water; then wash and dry it. If the reducing action is too great, dilute the solution further or shorten the immersion period. The reducer also will remove other fogs and stains and will increase contrast.—W. E. B.





SPLIT-SECOND SOUND was added to an 8-mm. camera (left, above) and a projector (right) by the use of ordinary recording equipment and a radio-phonograph. The recording speed was reduced from 78 r.p.m. to that of the projector sprocket, in this case 64 r.p.m. The camera was driven by the recorder motor through a gear box

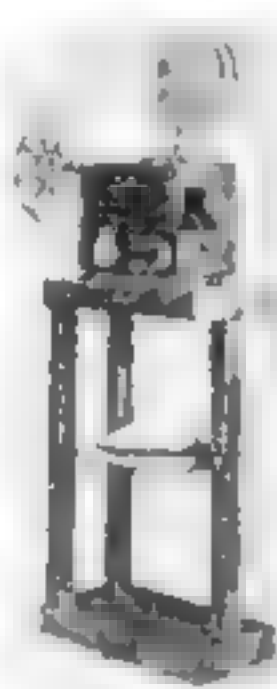
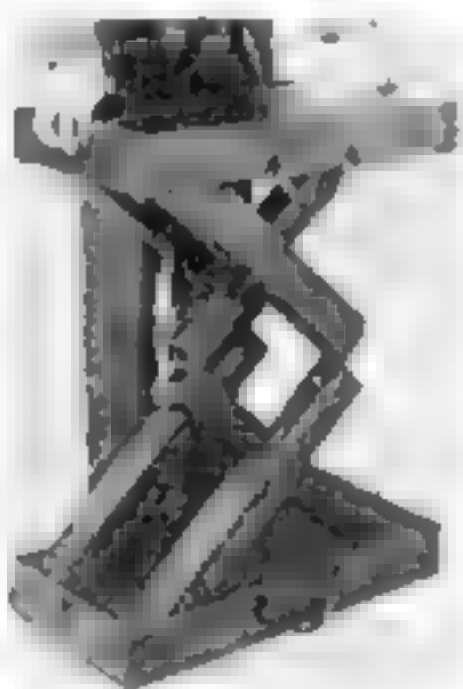
having the same ratio as the projector-sprocket teeth had to those of the camera sprocket. A flexible cable connected the radio-phonograph turntable to the projector sprocket, automatically reducing turntable speed. The arrangement permits recording 50' of film on each side of a 10" blank, or 100' per record.—DOMINICK SARCONI.

FOR CAMERA USERS

SOFT LENS TISSUE is now manufactured from American wood pulp, replacing Japanese tissue made from fibers of the Orient. It is free from abrasive particles, lint, and dusting, when wet retains 36 to 39 percent of its dry tensile strength, costs \$300 a ton compared to \$1,700 for the Japanese type, and goes further. It was developed by the Scott Paper Company, working with the Navy and the National Bureau of Standards.



AERIAL CAMERAS for use at 40,000', and Arctic war instruments, are tested by the Eastman Kodak Company in rooms where temperatures range from 45 to 70 deg. below zero. Anyone remaining more than three minutes must wear a special rubber mask.



THIS MOVIE-PROJECTOR STAND, folding so compactly that it can be carried like a light suitcase, is now available for home-movie enthusiasts. One side of its 12½" by 24½" case serves as the projector platform, and the other is a base for three 42" folding legs. Either 8-mm. or 16-mm. silent or sound equipment can be accommodated. Construction is bass-wood plywood, and the hardware is steel. The stand is made by Bell & Howell Company, of Chicago.



CAN YOU BEAT THESE PICTURES?

We will pay \$5 for any photo used on this page. Write your name and address on each print. Enclose a stamped, self-addressed envelope and the negative, if it is available, and send your contribution to the Curious Photos Editor.



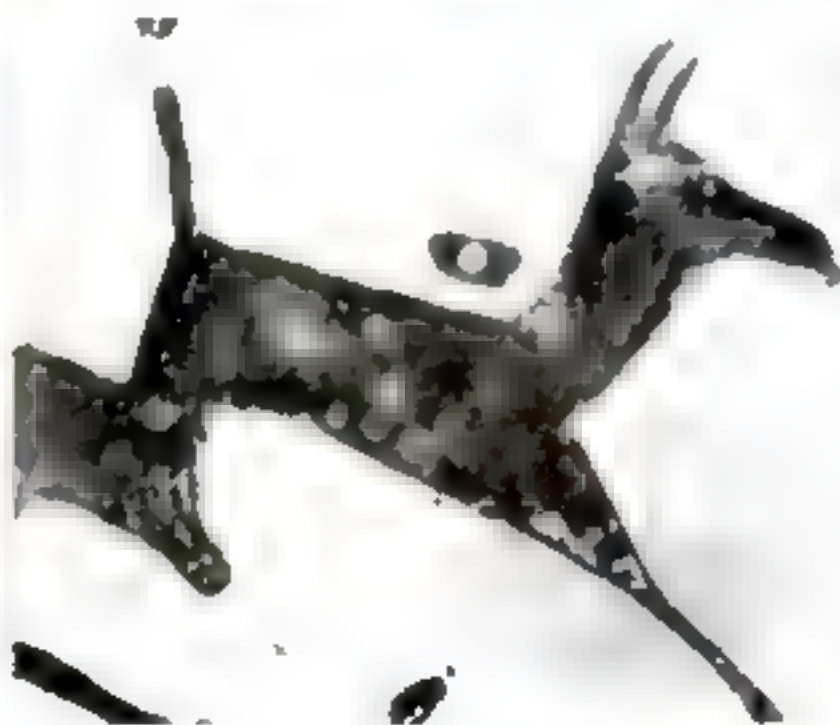
1,300 FEET UNDERGROUND, a lemon tree grows in the Bunker Hill & Sullivan Mine, Kellogg, Idaho. It is heated and watered by the naturally warm and damp atmosphere of the shaft and lighted with a sun lamp in an improvised coffee-can shade



STALKING A BUTTERFLY with his camera, Alden P. Armagnac, of P.S.M., got this rare shot when his subject decided to sit for its picture on his left index finger

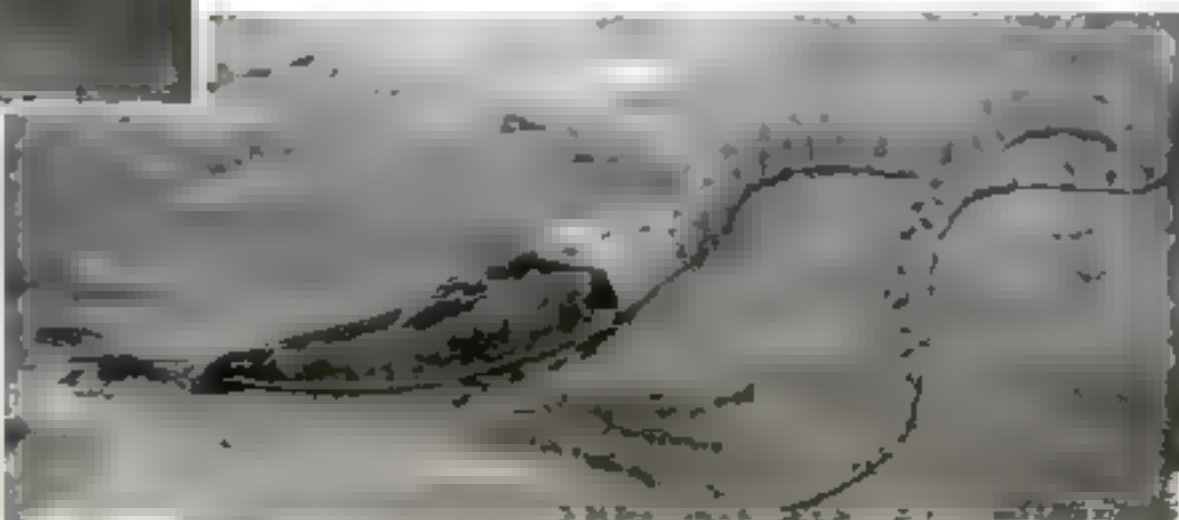


ONE-AND-ONE-HALF PACKS of playing cards were used by N. A. Haddad, of Jamaica Plain, Mass., in constructing this flimsy house of cards



MAGNIFIED 500 TIMES, stainless steel is here photomicrographically reproduced to show the strange, deer-like formation in which nature had arranged the constituents of the metal. L. A. Nowell, Jr., of Miami, Fla., a metallurgical technician, contributed this laboratory-taken picture

AN AMBITIOUS SNAKE, whose eyes seem to have been bigger than his stomach, is pictured below in the act of trying to swallow a fish. Jim and Sid Avant saw it in Garner State Park, Texas



AUTO IDEAS



THE JAPS HAVE A JEEP, as shown by this buggy that was captured by American troops on one of the former Jap-held islands. It looks more like an old-model touring car minus the top than one of our rough-and-ready jeeps, but the Yanks in it seem to be enjoying themselves.

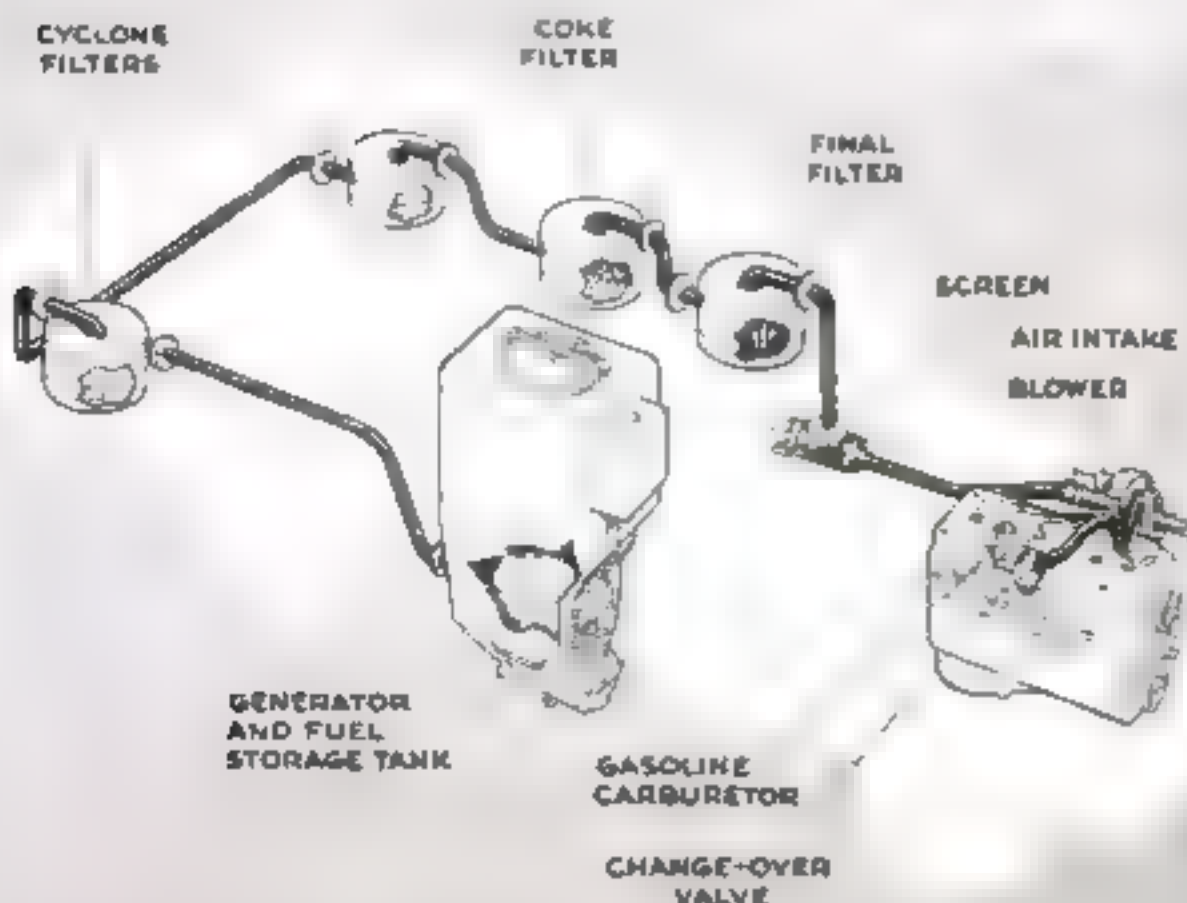
BUGS ARE DEFLECTED from the windshield of an auto, as is dust or snow, by a transparent winged device attached about halfway down the hood, as shown below. This deflector, the invention of William M. Parke, of Brook, Ind., is held to the hood by an adhesive that does not mar the finish. It is hinged at the center so that it will fold when either side of a side-lifting hood is raised, but it can easily be removed.



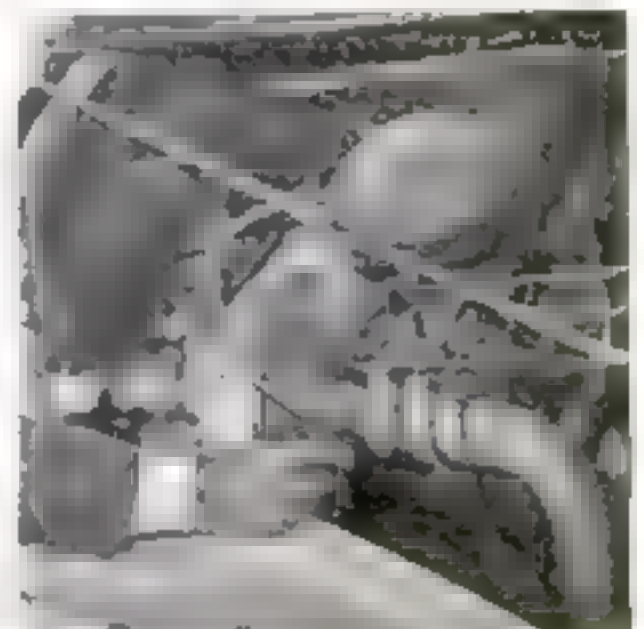
Charcoal and Water Are Converted into Gas That Runs Trucks

BURNING charcoal or coke in the presence of a small amount of steam, the portable generator shown installed on a truck at the right and in the phantom drawing below produces a combustible gas that will operate trucks and autos. Fuel is fed into the burner at the top, water drips into the fire chamber, and incomplete combustion takes place, sending carbon monoxide, free hydrogen, and some

methane to the engine through a system of filters that cool and cleanse the gas. The device is made by M. & R. Products, Inc., of Brooklyn, New York, and Kalamazoo, Mich.



Gasoline starts and operates the engine until enough charcoal gas is generated for changing over. The blower, shown below being adjusted, acts as a supercharger



Is Your Car Wasting Gas Coupons?

An Ordinary Vacuum Gauge, Used for Easy Tune-Up Tests, Will Aid in Getting the Best Fuel Mileage Your Auto Can Give

By TOM McCAHILL

DESPITE the incentive of gasoline rationing, scarcely one car in a hundred is kept in condition to give the fuel mileage that it might. Naturally, no exact figures exist, but many auto-servicing experts feel that the average car does not give more than 80 percent of its potential gasoline mileage. In other words, if your car is typical and if you're now getting about 16 miles per gallon, you're wasting four miles of travel for every gallon you buy—because you could get 20.

In a campaign to get more from you gasoline coupons, you'll probably find that it is the sum of a number of adjustments, rather than any single improvement, that will pay off. Your engine should be the first field of action in this campaign, because that is where your gasoline is spent and where the biggest gas-robbers usually lurk. A vacuum gauge will be found extremely useful in correcting engine faults and in tuning it up to peak efficiency. This gauge, which may be the same as those found on many vacuum-steam domestic furnaces, can ordinarily be

purchased at plumbers' supply houses for less than \$2. Be sure that the gauge has a scale reading from zero to 30" of vacuum.

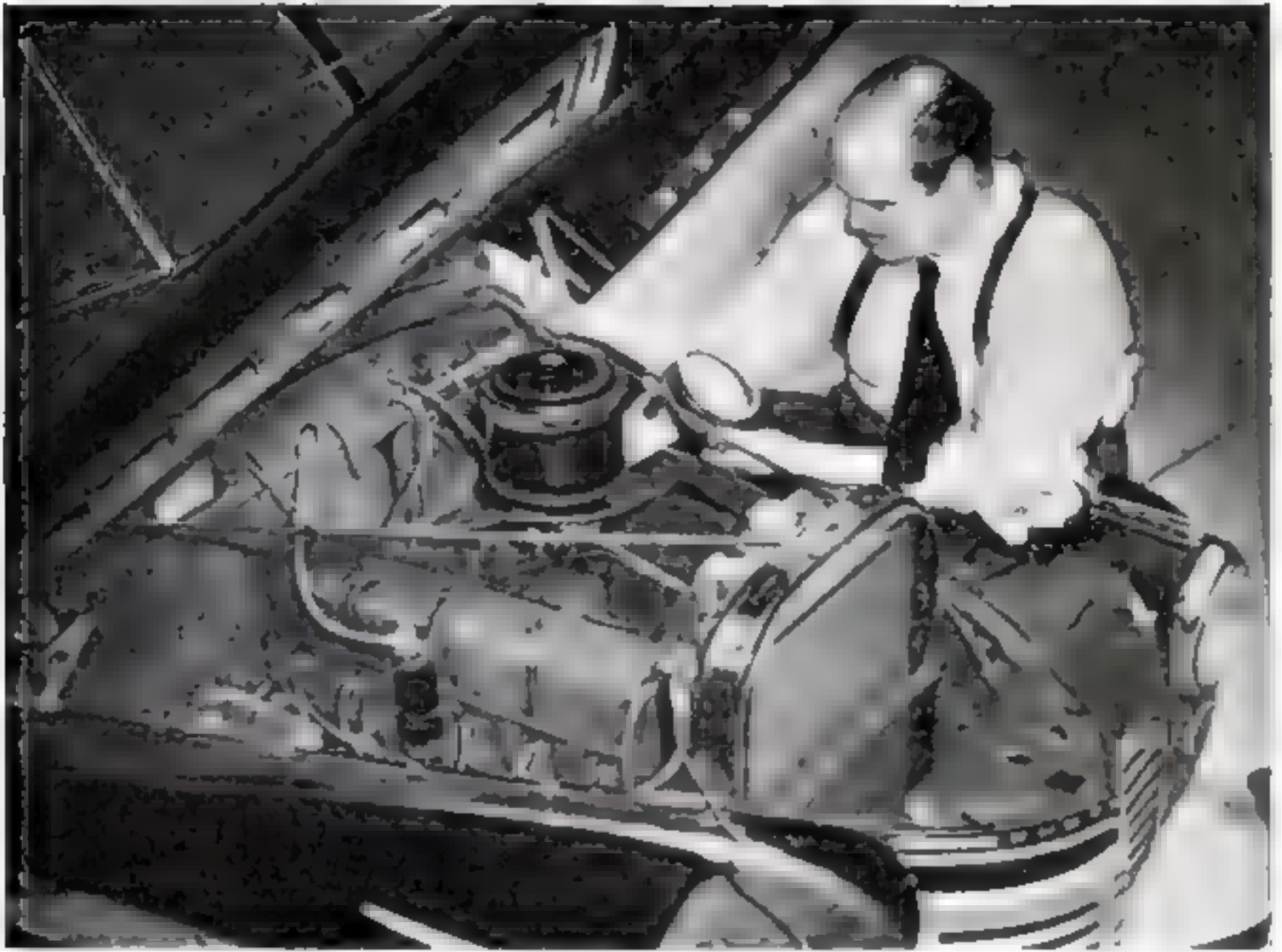
Spark plugs. First step will be to examine the plugs, perhaps the most crucial single part of a gasoline engine. Make sure that they are of the correct heat range for the engine in which they are installed, referring if necessary to the auto or plug manufacturers' specifications. If the plugs have been operated for some time without servicing, the chances are that you'll find an excessive gap between the electrodes, so clean them and set to the gap specified by its manufacturer.

It's also possible to test the plugs in the engine by shorting them out with a screwdriver having a well-insulated handle. Much can be determined about the condition of the plug by slowly drawing the grounded screwdriver away from the plug terminal and noting how far the spark will jump. A spark that jumps about the thickness of a nickel indicates that the plug is working satisfactorily; while one that won't jump more than .020" usually indicates a fouled plug. If on the other hand the spark will

Make sure that the spark plugs in your car have the proper heat range for the engine, that they are reasonably free of carbon deposits, and that the gap is correct. If you cannot obtain the car manufacturer's specifications, use a gap of .025"

Probably the most convenient spot to connect the vacuum gauge used in the tune-up is at the place where the windshield-wiper line joins the intake manifold. Pull off the rubber hose that leads to the wiper and attach the gauge hose in its place





The gauge used to tune up the engine is the same as those installed on vacuum-steam domestic furnaces

jump around $\frac{1}{4}$ " or more, the gap is far too wide, since the spark "prefers" to jump to the screwdriver instead of across the electrodes.

The next step in tuning up the engine is to connect the vacuum gauge to the intake manifold. On most cars the windshield-wiper pipe is tapped into the manifold and the gauge can readily be attached by pull-

ing off the wiper hose and replacing it with the gauge hose. If the engine is in average condition, the gauge will show between 18" and 21" of vacuum at idling speed. Bear in mind that the higher this vacuum can be raised on any given throttle setting, the more efficient the engine will be. In most of the following tests, an extremely accurate tachometer would do as well.

Timing. Spark timing can be adjusted with hairsbreadth accuracy by means of the vacuum gauge, provided the distributor points are set correctly. Here's how to do it:

The gauge pointer will rise and drop as you advance and retard the timing. Retarding will cause a comparatively smooth drop, whereas advancing will bring a rather erratic drop. First, retard the distributor slightly until you can see the retarding effect on the gauge, and then advance the distributor slowly until the maximum obtainable rise in vacuum has been achieved. When this point has been reached, the advance can be continued for several degrees without changing the reading, indicating that the firing position is at top dead center. Now retard the dis-

One ingenious use of a vacuum gauge is in diagnosing burned or sticking valves. Defective valve action of this nature will show a comparative vacuum drop every time the affected cylinder fires. By shorting a plug at a time, you can thus find where the trouble lies





Courtesy The Texas Co.

Distributor points should be examined periodically for excessive pitting, and dressed by means of a point file. Use a feeler gauge in setting the gap

tributor very slowly to a point where the hand is just about to show a retarding drop, and lock it in this position.

If the operation is done with care, you will find that practically perfect timing results. The writer has timed scores of engines, using timing lights, top dead center finders, and other instruments for the purpose. Timing by vacuum gauge is not only quite as accurate, but it also takes a small fraction of the time required by other methods. It is important, however, to remember that the distributor points must be set properly before timing is attempted.

An automatic spark-advance mechanism, either of the vacuum or mechanical type, may also be tested. This should be done after the timing is correctly set at idling speed. Open the throttle approximately three-quarters of the way and again advance and retard the timing setting. If you can increase the vacuum indicated, the automatic advance mechanism is not operating properly, for it should maintain the correct timing over the complete range from idling to full throttle.

Distributor. Since it's the nerve center of a gasoline engine, the distributor is often the cause of off-peak performance. Here are a series of quick checks you can make to be sure it is not wasting your gasoline.

First, remove the cap and examine the inside of it. If the cap is shorting, there may be bluish-gray traces left on the surface, or tiny cracks near the electrodes. A cap in this condition should be replaced, for it will cause poor performance and make starting in damp weather extremely difficult.



With this vacuum gauge, the timing can be adjusted very easily. The distributor should be advanced or retarded until the gauge shows the highest reading

Next examine the condition of the points. If either the stationary or moving points show substantial pits or deposits, the condenser and its connections should come under immediate suspicion. Points in good condition will be gray in color and can be readily cleaned with a point file.

A condition which very few mechanics will think to check, but which can be extremely important, is a weakened point spring. This will result in poor performance and even missing at high speeds. In the writer's opinion, it is something that has caused more unnecessary changing of carburetors, coils, and condensers than any other single motor ailment. If it's inconvenient to have the spring tested in a service station, borrow or purchase a point-spring scale, obtainable from several manufacturers for about \$1.50, and see if it has the minimum tension required for proper operation. The correct tension can be learned from a service station dealing in your make of distributor.

Distributor experts can often check the point gap with exceptional accuracy without looking at the points, for their trained eyes can tell at a glance what the gap must be by the shiny section on the cam. Since the cam opens and shuts the points by bearing against the fiber on the breaker arm, the part of the cam which touches the fiber will be shiny and the part which does not touch will be dull. In most distributors, if two-thirds of the cam area is dull and one-third is shiny, the point setting will be approximately correct. However, unless you are very familiar with the way your cam

should look, don't rely on this check, but instead use a feeler gauge in setting the points to the manufacturer's specifications.

Carburetor. It is possible to make sensitive carburetor adjustments with the vacuum gauge. You'll notice that as the mixture adjustments are changed, the vacuum reading rises and falls. The highest reading obtainable on a fixed throttle setting will be the correct setting. If your carburetor has separate idling and high-speed adjustments, place the throttle in the appropriate speed range before making the adjustments.

Many autoists have labored under the notion that a carburetor adjusted for top performance will not be economical, and that one set for maximum economy will not give full power and speed. This is not entirely correct; a properly adjusted carburetor will produce both good performance and good economy.

Fuel Pump. If you suspect that your fuel pump does not deliver sufficient gasoline at high speeds, test it by means of the vacuum gauge. Disconnect the intake pipe and attach the vacuum-gauge hose to the pump; then run the motor at idling speed by means of the gasoline already in the carburetor. The pump should show from 5" to 11" of vacuum. If it doesn't, it should be removed, dismantled, and inspected for faults.

Valves. Burned or sticking exhaust valves will be indicated on the vacuum gauge by a drop of 2" or 3" every time a cylinder with a defective valve fires. By shorting out one cylinder at a time you can locate the bad valve; when its cylinder is shorted out, the pointer will stop its erratic dips.

Compression. Poor compression can be located in the same manner. If difficulty of this sort is suspected, start shorting out one cylinder at a time and note the drop in vacuum caused by each inoperative cylinder. Let's assume that five of the cylinders in a six-cylinder engine cause drops ranging from 1½" to 2", while one cylinder brings a drop of only 1". You may be sure that the latter cylinder is the weak one, with poor compression caused by bad rings or valves. If the test shows fairly uniform drops for all cylinders, compression trouble can usually be ruled out.

Mixture controls on the carburetor are turned carefully until the hand on the vacuum gauge is as high as possible. A high-speed jet can be adjusted only if the engine is turning at a good speed

With practice you will find that you can even make what doctors call a "differential diagnosis"—that is, you can tell with fair accuracy whether trouble of this nature lies in valves or rings. Compression loss resulting from bad valves is generally shown by a larger drop and by erratic behavior of the pointer, whereas ring trouble is characterized by a lesser and more regular drop.

Aside from the engine there are auto ailments elsewhere that can steal from the true value of your gasoline coupons. One of them, not often recognized at its real importance, is underinflations of tires. To visualize how much this can mean, remember your bicycling days—how hard it was to pedal when the tires were low, and how much easier it became when you pumped them up. Actually, inflation of tires to a pressure from two to 10 lb. above manufacturers' specifications increases mileage.

Four other potential fuel wasters should also be considered. Unnecessarily heavy lubricants in the transmission or rear end, dragging brakes, misaligned front wheels, and careless driving habits—which include jack-rabbit starts and overuse of the gear-shift lever and choke—are capable of making a deep cut in the gasoline mileage that your car can give.



Gus Referees an Election



WHEN the business men of our town got behind George Knowles for mayor, the crowd at the Model Garage turned into red-hot politicians. George had been one of the first customers when Gus Wilson and Joe Clark opened their shop and, although he's grown into a big shot since then, he's never fallen out of the habit of dropping in a couple of times a week and sitting around with the boys.

George ran on an honest-government platform, and mighty few people in town had any doubt about our needing a lot more honesty in government than we'd been getting. Mayor Rufus P. Belcher, who seemed to have a mortgage on the office, is a politician of the old school. He's a fat man

with a pink-and-white complexion, and he wears the last cutaway coat left in circulation in our neck of the woods. Whenever he makes a speech, he starts off the same way. "My dear-r fr-iends," he says, "the gr-reat and glo-rious party I serve, however humbly—" Then, seemingly overcome by emotion, he breaks off, pulls a big white handkerchief out of the side pocket of his cutaway, gives it a flip in the air, and blows his nose. After that, he opens up and really puts out the old hokum.

It didn't take George Knowles long to heat up the campaign. He carried the fight to Belcher by attacking the way in which he had handed out contracts to henchmen, and—being an accountant by profession—he

Fight



By
MARTIN BUNN

band playing its head off, and all the other trimmings. Our Model Garage gang went in a body. Old Judge Keegan, the chairman of the meeting, was in his place and George in his, but Belcher's seat was empty as time for the debate arrived. There was a long wait, which the band filled in by playing its loudest. We killed the time watching a pretty redhead taking flash pictures of the local celebrities. None of us recognized her until Stan Hicks, the Model Garage grease monkey, said she was Mary Manning, who'd been his steady date in high school and whom Carpenter had hired as photographer-reporter on the Sentinel.

When Judge Keegan couldn't stall any longer, he introduced George and told him to go ahead with his speech. That wasn't so good for George. He'd written out a speech and had worked in a lot of embarrassing questions. Now he had to fling them at Belcher's empty chair, and after awhile it got to be so much like watching a fellow shadowbox that people had to laugh. But George said what he had to say—which was plenty.

A boy handed Judge Keegan a note. When George finished, the judge got up and announced he'd received a telephone message from Mayor Belcher saying that his car had broken down while he was returning from a trip and that he wasn't able to get back. There was nothing to do but close the meeting. The Belcher people went home grinning.

Then when the Sentinel hit the street on Monday, we got a big surprise. George's charges were on the front page as we had expected, but so was Belcher's countercharge that his car had been tampered with to keep him from answering. He demanded a full investigation and offered to submit his car for examination to an expert. Carpenter named Gus, and the examination was set for four o'clock that afternoon.

By a quarter to four there were at least 100 people milling around in the Model Garage driveway and overflowing into the shop. All our gang was there, and so were a lot of Belcher people. Mary Manning, the Sentinel's redhead, had a camera slung around her neck and a wad of copy paper in her hand, and she was busy on her story for

talked figures that the Honorable Rufus wasn't able to explain away.

Syd Carpenter, editor of our local daily, was in the fight on Knowles' side, and the week before election he had a bright idea. He arranged a big meeting for Saturday evening, and invited the candidates to debate the issues. George was only too glad to accept—he'd dug up some new evidence on Belcher's financial juggling. The Honorable Rufus, who knew what he had uncovered and didn't have any plausible answer, tried to side-step, but the Sentinel went after him so hard he had to accept.

It was a real old-fashioned political rally—prominent citizens trying to look at ease on the bunting-draped platform, the town



Someone had taken the gasket from the fuel-pump filter bowl and put it in a drawer of the workbench in the Mayor's garage

the extra Carpenter was going to publish as soon as the examination was finished.

On the dot of four, two cars came slowly up the driveway, one towing the other. Mayor Belcher got out of the towed car and addressed Gus in a voice intended for the crowd. While hurrying back to town Saturday evening, he said, he stopped at a roadside restaurant for a hasty bite. When he returned to his car he noticed a man hurrying away from it, but thought nothing of the incident and started up for the meeting. After he had gone perhaps 100 yards, the engine began to buck, and the next moment it went dead. He tried to start several times—the car would run a short distance and then stop. Very unwillingly he was forced to the conclusion that the failure of his car to—er—function properly had resulted from the machinations of unscrupulous political enemies determined to deny him the opportunity of replying to the scurrilous charges they knew were to be made against him at the meeting. He had his car towed home, and since then he had neither driven nor touched it. Now—with a sweeping gesture—he turned it over to Mr. Gus Wilson for what he hoped would be a fair and impartial examination.

Everyone crowded around as Gus got into Belcher's car and stepped on the starter. Nothing happened. Gus pulled out the choke and tried again. This time the engine popped and started, ran a few seconds, sputtered, and stopped. Gus started it again and drove into the shop. The crowd followed.

Aided by Stan Hicks, Gus went to work. The ignition system tested O.K., the fuel line was clear, and the carburetor seemed all right. Gus scratched his ear, and then started to re-examine the fuel pump. He slipped off its filter bowl, looked at it, and held it up for everyone to see.

"The reason the Mayor's car won't run properly," he announced, "is that the gasket is missing from the fuel-pump filter bowl. Without the proper seating for the filter bowl provided by the gasket, air sucked into the fuel line kills the engine. It can be restarted by using the choke as the increased suction draws some gas, but it soon dies again. The gasket was, of course, removed by someone. Who that was, or when or why he removed it, I have no way of knowing."

That started a dogfight, with accusations flying back and forth like brickbats. Mary whispered to Stan, and they went out.

When they came back 15 minutes later, the row was beginning to die down. Mary stepped up beside the Mayor and urged him to say something.

One of his henchmen brought over a chair, and Belcher climbed up on it. Mary backed away, got her camera focused on him and her flashlight apparatus ready for action.

"My dear-r fr-iends," Belcher sounded off, "the gr-reat and glo-rious party I serve, however humbly—" Then he broke off as usual, hauled his handkerchief out of his pocket, gave it a flip—and flipped a filter-bowl gasket right into the crowd!

While it was still in the air, a flash bulb flared and Mary's camera clicked. The instant the gasket hit the floor, Syd Carpenter pounced on it and yelled: "Here it is, folks—the missing gasket that kept His Honor from attending the meeting. He had it in his pocket all the time!"

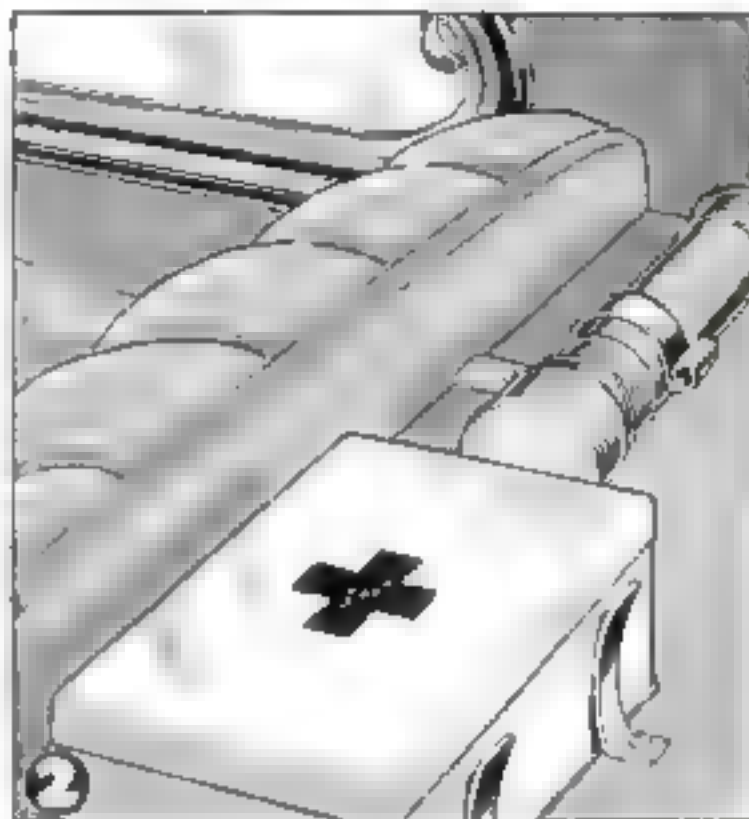
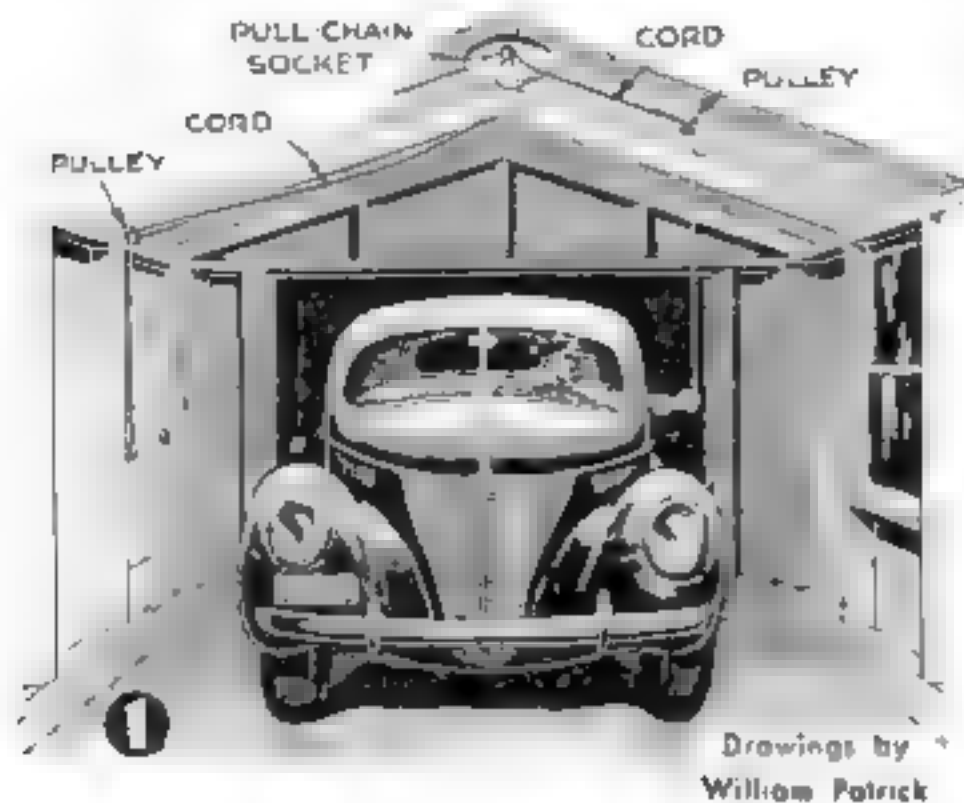
The Sentinel's extra was on the street late in the afternoon, and on the front page was a big picture of Mayor Belcher flipping that gasket out of his handkerchief. Voters went to the polls next day with the paper sticking out of their pockets and grins on their faces.

Knowles' headquarters were in the Park House, and in the evening we all went there to hear the returns. There was no doubt about the results—George won by a mile.

"It'll be great for the town," Gus Wilson said. "But there's one thing I can't understand—why Belcher was fool enough to carry that gasket around in his pocket!"

Mary had stopped at our table while she waited to get a picture of George Knowles. She smiled. "Stan and I had a little to do with that," she said. "When you found what was missing from our ex-Mayor's car, Stan and I went to his garage. He found the gasket in a workbench drawer, and I took it—and slipped it into Mr. Belcher's pocket when I asked him to make a speech."

USEFUL AUTO HINTS

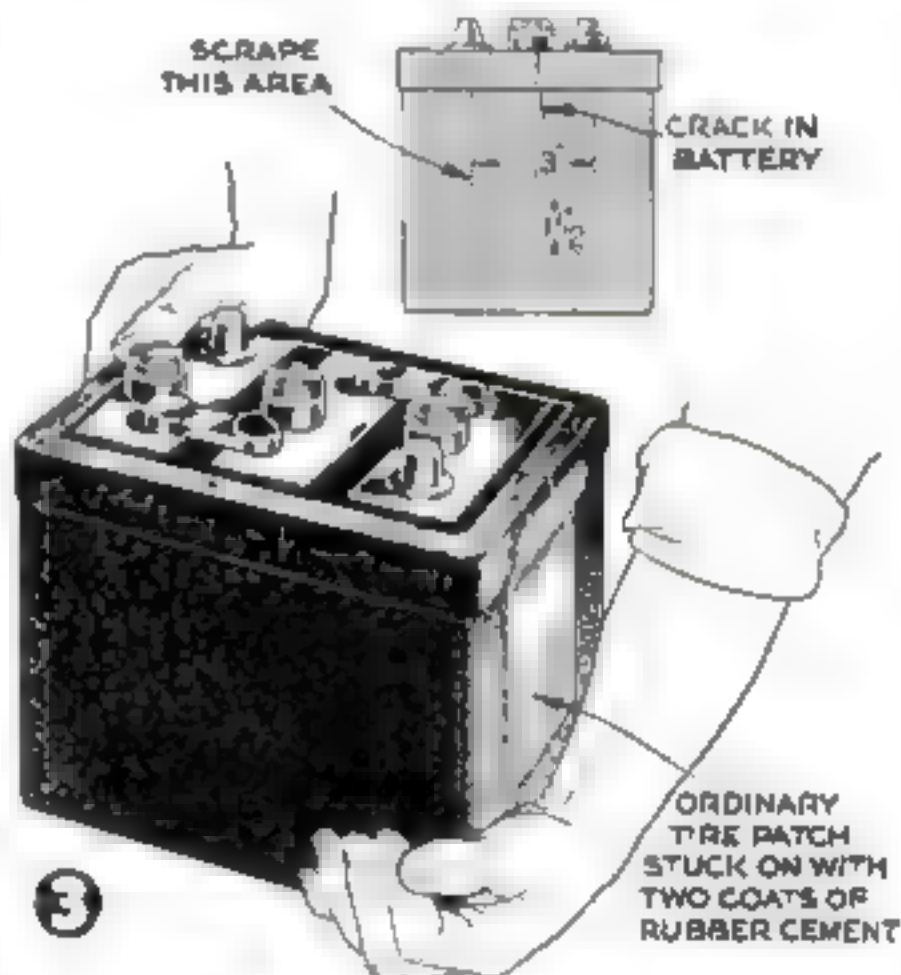


1 A LIGHT IN A GARAGE may be turned on or off both from the front seat of a car and from the house entrance or garage door by installing a pull-chain socket for the bulb and arranging pulleys and extension cords as shown in the drawing. The main switch should then always be left on so the light circuit can be closed or opened by the pull-chain switch.

2 FIRST-AID EQUIPMENT, a flashlight, a fire extinguisher, pliers, an adjustment wrench, and other small tools can be kept efficiently without rattling in the space just in front of the rear window by installing wood cleats and various metal clips of the type found in 10-cent stores. This saves the glove compartment—often cluttered with articles of this kind—for road maps and the like, which are frequently needed more urgently.—J. A. A.

3 BATTERY FAILURE caused by leakage through a crack in the case at an end cell can be forestalled in an emergency with an ordinary tire patch. Scrape down the case with a chisel and sandpaper, making a smooth, rectangular area about $1\frac{1}{2}$ " around the crack; then apply rubber cement to this spot and the patch, and stick the patch on. Replace lost fluid with electrolyte of the proper specific gravity.—J. W. M.

4 VALVE-GRINDING COMPOUND placed on the underside of brackets held to a cylinder head by the nuts on the cylinder-head studs will keep these fixtures from turning annoyingly when the nuts are tightened. A small amount of compound is enough to provide a firm grip between a bracket and the cylinder head.—R. D. L.



Wooden Skillet Made from Chopping Bowl Is Used for Candy



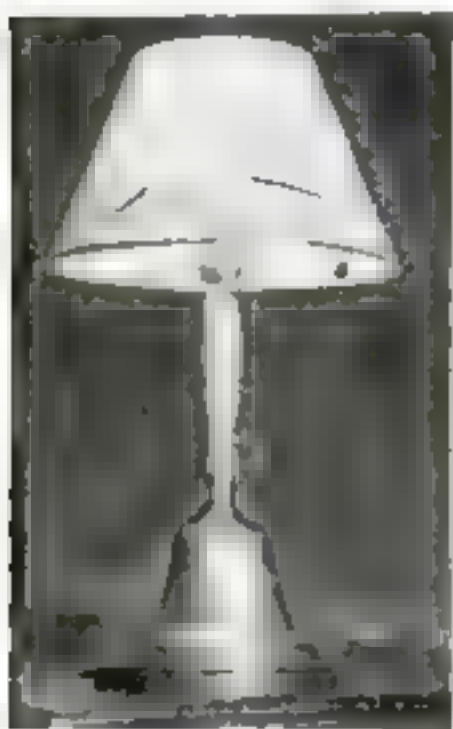
FOR a quick shop project, assemble a serving "skillet" from a small maple chopping bowl and a file handle to match. It can be used for candy, nuts, and small sandwiches, or as a pin tray or catchall.

If the bowl has a wax finish, remove it with cleaning fluid; then scrape, if necessary, with curved glass, and sand. Saw the ferrule end off the handle diagonally and file to fit the contour of the bowl. Drill and countersink three holes in the handle for flathead screws. File off any projecting portions after assembly.

Finish with clear lacquer, varnish, or wax, staining beforehand if you wish, or make a French polish of equal parts linseed oil and



white or orange shellac, apply a little at a time with a cloth pad, and rub immediately to a high gloss. Repeat until the gloss remains after the finish has dried for several hours.—W. E. B.



Old Dinner Bell Converted into Unusual Desk Lamp

FITTED with a socket, an old dinner bell of the type once widely used on farms makes an interesting desk lamp. Tap the hole in the top of the bell and drill the handle for a length of $\frac{1}{2}$ " pipe threaded at both ends. If the old handle can't be drilled, turn a new one in the lathe, and use the old iron ferrule. Turn a wooden base on the faceplate, or shape it with a coping saw and a rasp, and attach it with a bolt and a piece of strap iron bent as shown in the photograph at the right.—JOHN M. AVERY.



Two Chopping Bowls Fitted Together for Handy Sewing Basket

TWO wooden chopping bowls, one about $10\frac{1}{2}$ " in diameter and the other 9", can be turned into a sewing basket by screwing three pot-lid knobs to the larger for feet and one to the smaller for a handle. Use one of the finishes suggested for the serving skillet described above, or apply bright enamel, using different colors inside and out.—J. LEORA BROWN.



SCULPTURED ICE FORMS BANQUET CENTERPIECES

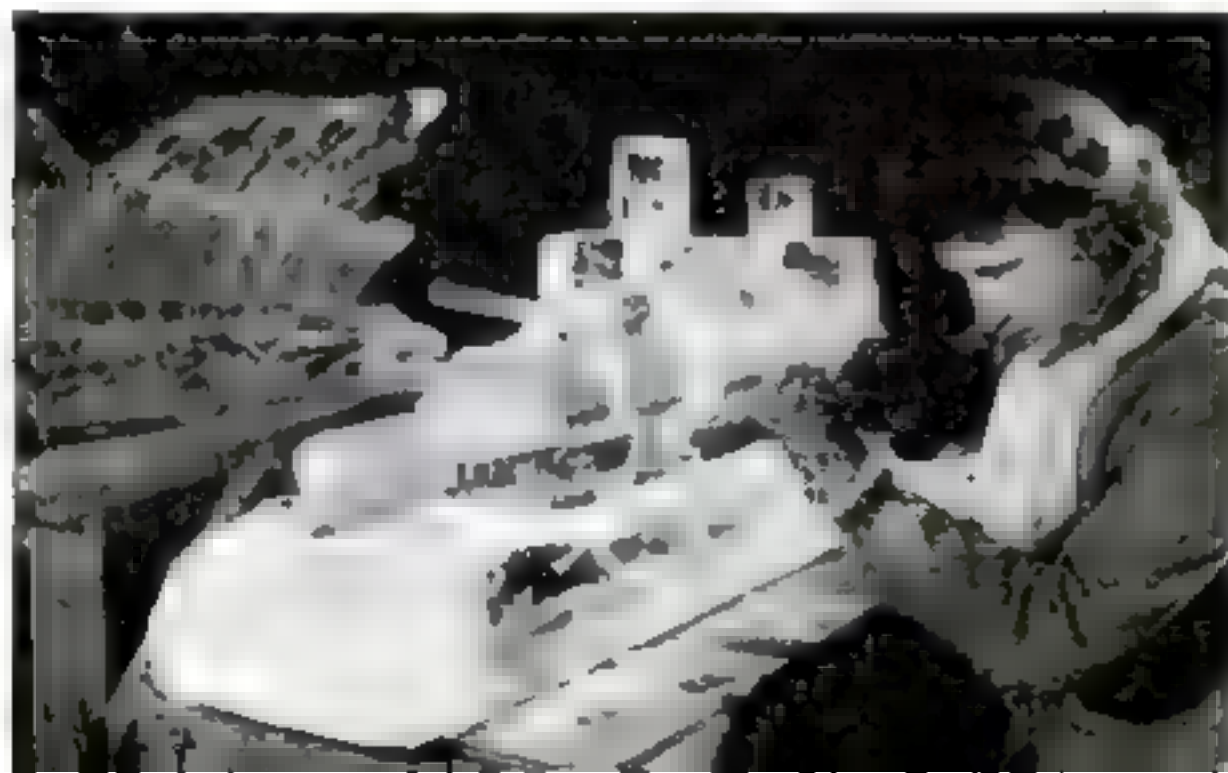
SWATHED in overcoat, galoshea, muffler, and warm mittens, Madeline Stone, of Arlington, Mass., maintains an odd studio in the plant of the Boston Ice Company at Dorchester. There, in a temperature of 28 deg., this 22-year-old sculptress works nightly on big blocks of ice, forming them into interesting punch bowls and artistic centerpieces for banquets and parties. By day, she is a commercial artist and works with less demanding—and more permanent—materials than ice.



This model of Cupid, chiseled from glistening ice, will form the centerpiece of a large banquet table, as also will the icy swan in the background. Madeline Stone is the sculptress



It's work that requires—and gets—a cool head. At the left, Miss Stone saws a block of ice into size for such a masterpiece as the battleship on which she is shown putting the finishing touches below. Most popular of all her numbers are the ice bowls shown at the right. They serve as containers for oysters, shrimp, fruits, and beverages. Miss Stone uses a special drill for cutting out the concave centers





AFTER Mario has worked on it, one supports a console table in the Park Avenue apartment of the Countess von Etzdorf. The mirror also is Mario's

By **LOUIS HOCHMAN**

TO THE average passer-by, the razing of an old-fashioned brownstone house in New York means only the passing of another out-moded mansion. But to Mario Ammaribile, who owns a small antique shop on the upper East side, the over-ornate architectural trim of such a building is raw material for distinctive furniture that may find its way to some fashionable Park Avenue apartment. Mario makes a specialty of salvaging such

Old House

COLUMNS, BANISTERS, AND



BEFORE skyscraper apartments came, four and five-story buildings like these were mansions in New York. Then many became tenements, and many are now being razed. Note the cornices under the eaves and follow them to Mario's shop, shown below



ornamental junk from demolished houses and converting it into unusual pieces.

When an old building is slated for destruction, Mario arranges with the owners or wreckers to get such decorative portions as cornices, banisters, moldings, mantelpieces, window shutters, and fluted porch columns with ornate capitals. These are usually hand-carved masterpieces of a bygone era—monstrosities now in their original settings, but not in the artistic eyes of Mario, who visualizes them as something entirely different.

Trim Yields Fine Furniture

OTHER PARTS OF WRECKED BUILDINGS MAKE UNUSUAL PIECES



BEFORE the land it occupied was needed for a modern building, this old-fashioned house boasted once-handsome porch columns. Below, Mario cleans sawed lengths of the columns down to the wood in a special lye bath. The scrubbing requires hours



An elaborately carved Corinthian capital may look grotesque on a dilapidated building, but cleaned, refinished, and used upside down as the base of a circular mirror-topped table, it becomes an unusually decorative piece of furniture. Porch columns, too, either fluted or plain, make striking bases for modernistic coffee tables, when cut into short lengths. Battered window shutters may be cleaned, given a coat of fresh paint, and converted into modern screens. Other ornate fixtures can be converted either whole or in



AFTER being fitted with a plywood top (shown below as it is sawed) and a gleaming mirror, one length of column becomes a base for a modern table



part into novel table lamps or special fixtures for indirect lighting.

Mario's ability to visualize the artistic possibilities in the ornate junk he acquires is his stock in trade. Customers often bring in



Mrs. Warren F. Lutz serves tea on a table by Mario that is in the apartment of Mrs. William Rodenwald. Below, Mario and one of his men plan to use an ornate column



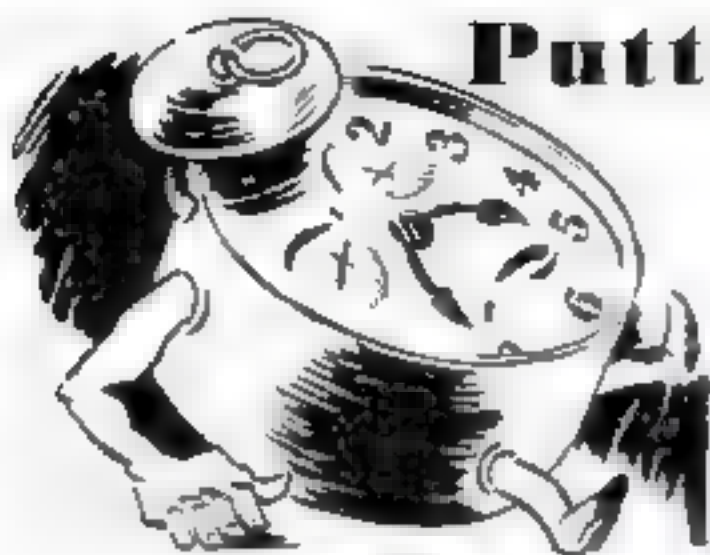
salvaged pieces of their own, and together with Mario decide what to make of them. For one who wanted indirect lighting for his modernistic apartment, Mario took a pair of old porch columns, scooped out the tops to accommodate light bulbs, and gave them a pickled finish. The two now stand majestically on either side of a wide arch. Many of Mario's customers come from fashionable Park Avenue apartments and are listed in the social register. One of his best is Gypsy Rose Lee, whose home is a veritable showroom of Mario creations.

The first step in "glorifying" a piece of salvaged junk is to clean it thoroughly of its worn and dirty finish. This, Mario does in a large tub containing a solution of lye and special paste. From three to four hours of washing and scrubbing are required to clean the piece down to its bare wood. Then it is allowed to dry for 24 to 48 hours. Next, Mario goes over the carved design and, using wood putty, reconstructs broken and chipped portions. He

fills in large cracks, leaving only the fine ones to preserve an antique quality. Then Mario converts the piece into whatever type of furniture or fixture it is suited for, cutting and adding parts as needed. Finally, he paints it or gives it a pickled finish by rubbing flat white into the raw wood, and shellsacs or waxes it with paste wax.

Wooden shutters like the ones shown at right once served as Venetian blinds in fashionable homes. When not in use, they were folded into the sides of the windows where the paneled sections became trim. Mario rearranges sections and adds paint to make modern screens.





Putting Old Alarm Clocks Back on Their Feet

BY R. F. BERTRAND

MOST of the faults that develop in that household stand-by, the alarm clock, can be put in order by the amateur trouble-shooter. He should be sure, though, to lay out all removed parts carefully so they can be returned to their proper places. The only tools needed are a pair of long-nose pliers, a small screw-driver, a sewing needle, an ordinary pair of tweezers, and a camel's-hair brush. A small amount of clear, unleaded gasoline is necessary for cleaning, and a little watch oil should be obtained from a jeweler or at a jewelers' supply house.

Remove the works from the case without disturbing the face and hands by unscrewing the winding keys and taking out the screws that hold the back. Then, regardless of what else may be wrong, clean and lubricate the clock. Pour some gasoline into a tumbler and apply it to all working parts with the camel's-hair brush, as in Fig. 1. Use plenty of fluid in cleaning so it will wash away the dirt. Rinse the brush in gasoline frequently and wipe it on a clean cloth. Never use gasoline near a flame, and if possible, clean the clock outdoors.

Use the watch oil sparingly after letting the gasoline evaporate from the parts. Put a few drops in a spoon or small saucer, and apply it to bearings, gear teeth, and other working parts with the point of the needle, as shown in Fig. 2. Be especially careful not to get excess oil on the balance wheel as it will work to the edge and change the period, affecting the accuracy of the clock.

Perhaps the most serious trouble you will encounter is a broken mainspring or an alarm spring. Remove the screws holding



the mainspring arbor plate; then lift off the spring assembly, as in Fig. 3.

Before taking the spring itself out, however, allow the clock to run down, or release the tension by lifting the dog and, using the winding key to retard the action, letting the spring unwind slowly. Hook a new spring onto the gear shaft by engaging the slot stamped in it with the lug that holds it.

Still simpler to handle is adjustment of the balance wheel to compensate for wear. This wheel is likely to wear first. Tighten the pivot screw a little (Fig. 4), but not so it binds the wheel.

Be sure to check for clearance between the hands and between them and the face and glass. If it is insufficient, spring them with the tweezers.

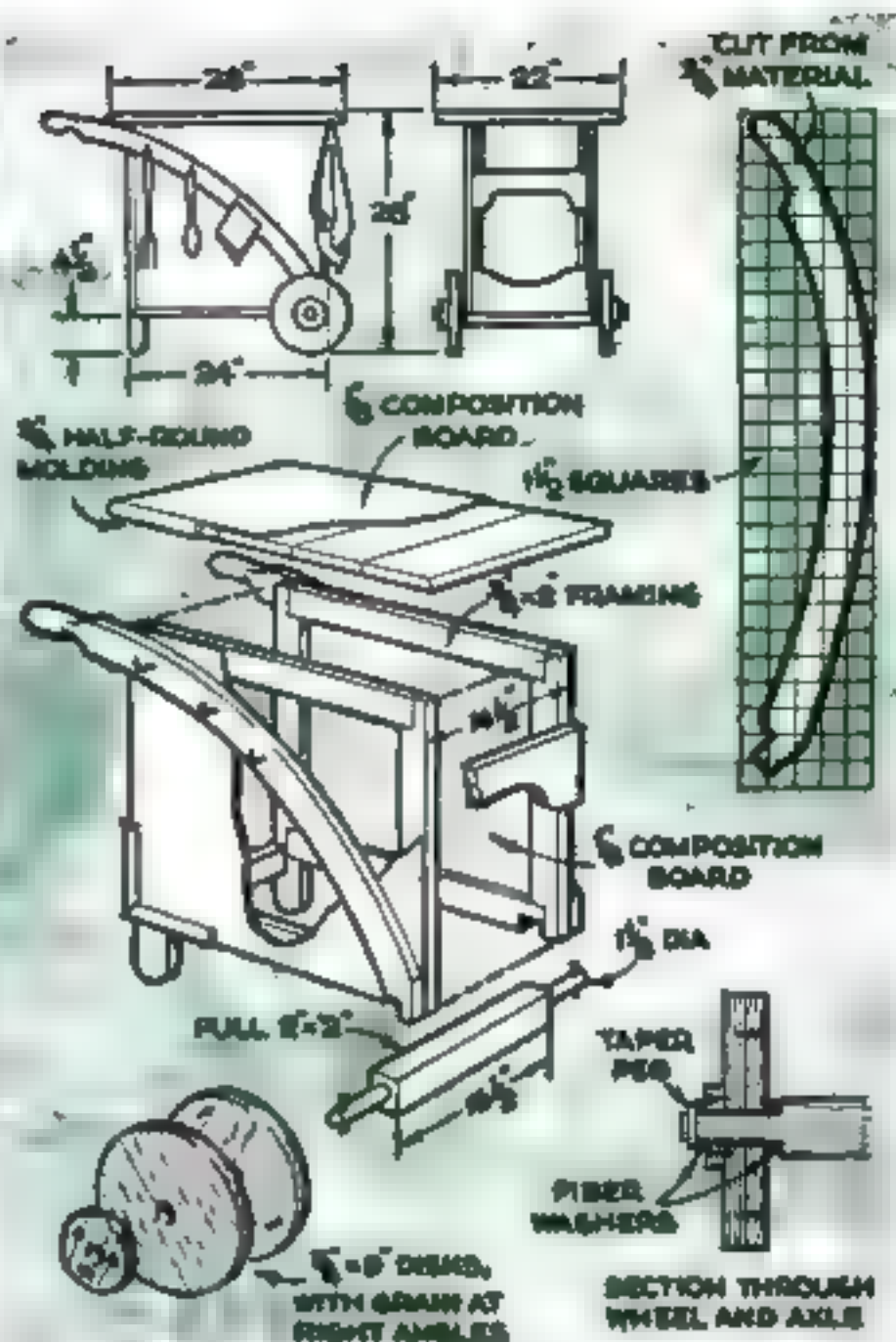




Food Tender Is Step Saver for Dining Out of Doors

CARRYING plates, utensils, food, and other items from the kitchen for picnics and dinners on the lawn can be a chore requiring many steps, but with this handy tender the job can be done in one trip.

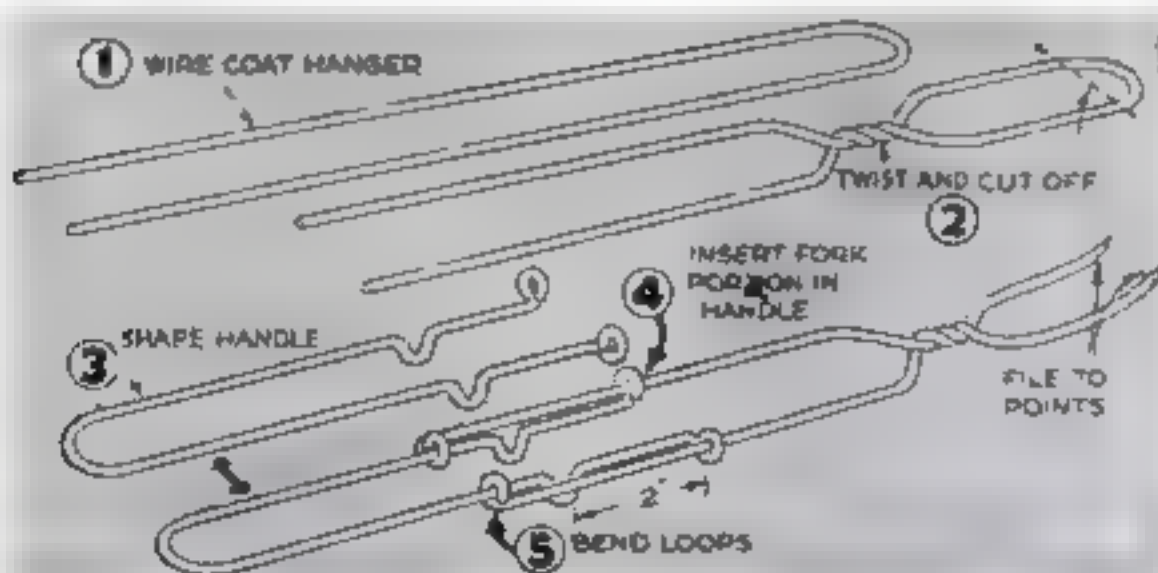
Short lengths of stock are used for the frame and scrap pieces for the wheels and top. Thin composition-board panels cover the top and sides, finished at the edges with half-round molding. Wheels are made of two disks glued and screwed together with the grain at right angles. They turn on wooden axles that are impregnated with



paraffin. This can be done by holding the ends in a pot of melted paraffin for several minutes. Keep the paraffin over a fire during the process, and the wood will absorb a quantity. Tapered pegs on the outside of fiber washers hold the wheels on.

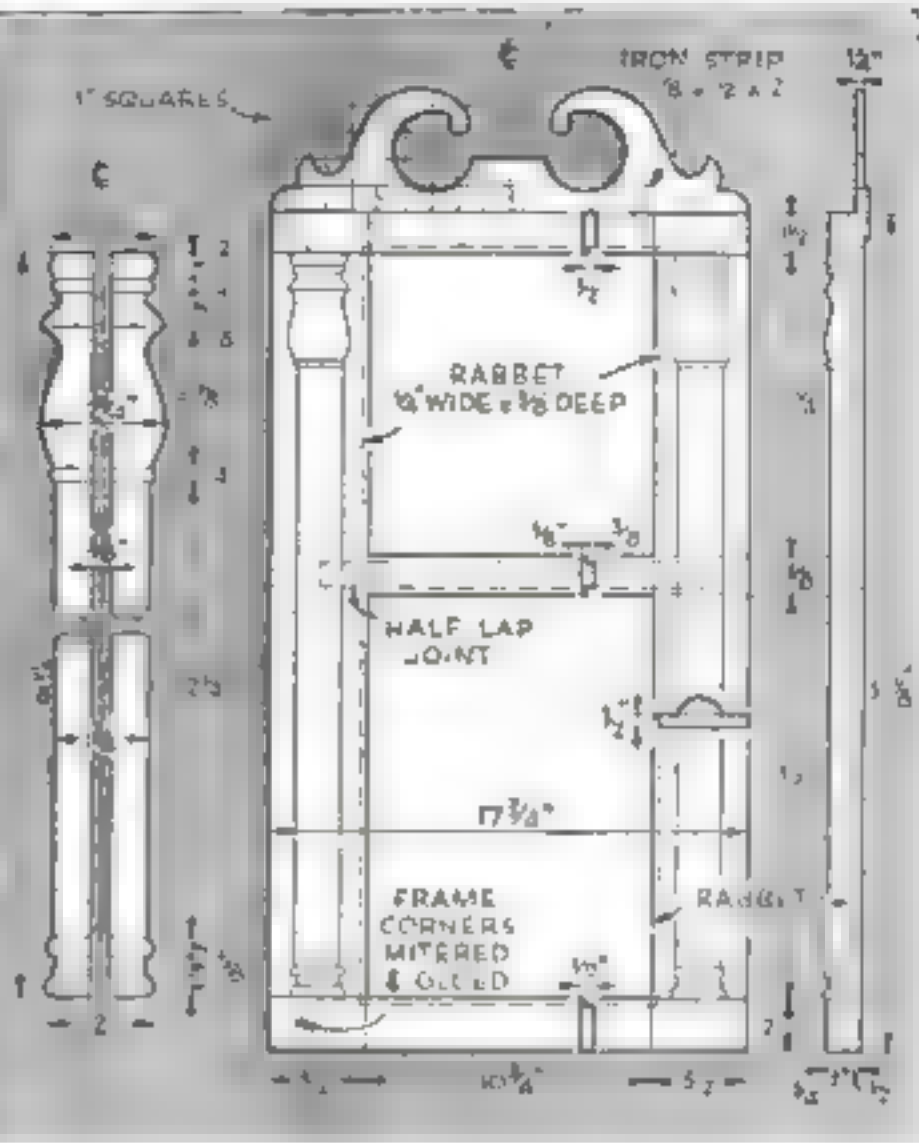
Curved pieces, scroll-sawed from $\frac{3}{4}$ " pine, are attached to the side for hooks to take ladles, forks, spoons, and other cooking and serving implements. Their extensions are rounded for handles. Attach them before putting on the side molding, and cut the molding to fit against them.—HI SIBLEY.

Barbecue Fork Is Made in Two Sections to Keep Handle Cool



SHAPED from two wire coat hangers, this fork is long enough for broiling wieners, and yet can be telescoped to fit into a picnic kit. Bend and twist one wire, as in Figs. 1 and 2, and cut off and file the end to points. Shape a second wire, as in Fig. 3; then insert the first through the loops (Fig. 4) and bend loops at its end (Fig. 5). The handle should slide with some friction.

Eighteenth Century Mirror Reflects Good Taste



By NORBERT ENGELS

SIMPLE construction marks this eighteenth-century mirror, which embodies the characteristic lines of furniture of its time. It will be appropriate on the wall of a living room or entrance hall, or it can be used to advantage in a period bedroom. Walnut or mahogany will make an attractive piece, as will other suitable woods.

Turn the two pilasters as a single piece, and saw this lengthwise $\frac{3}{16}$ " off center on each side. Build the frame with mitered

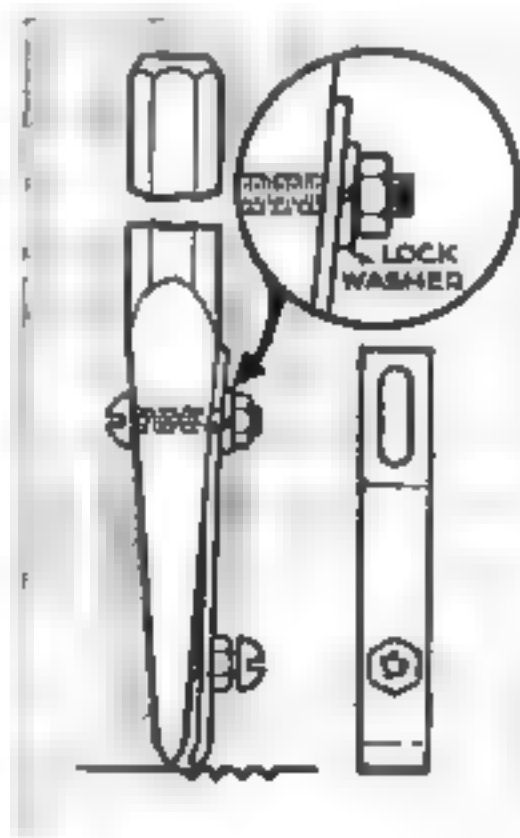
and glued corners and with a rabbeted back to take one or two mirrors and a backing of cardboard over which paper may be glued to keep out dust. Then glue and brad the pilasters to the frame, driving in 1" brads from the back, and add the $\frac{3}{4}$ " thick blocks for bases and capitals. These, also glued and bradded from the back, will strengthen the mitered joints. The decorative top piece, designed as a broken pediment, is held to the frame by two flat strips of iron, each drilled and countersunk for two $\frac{1}{2}$ " screws. If a single, full-length mirror is used, the dividing strip may be eliminated.

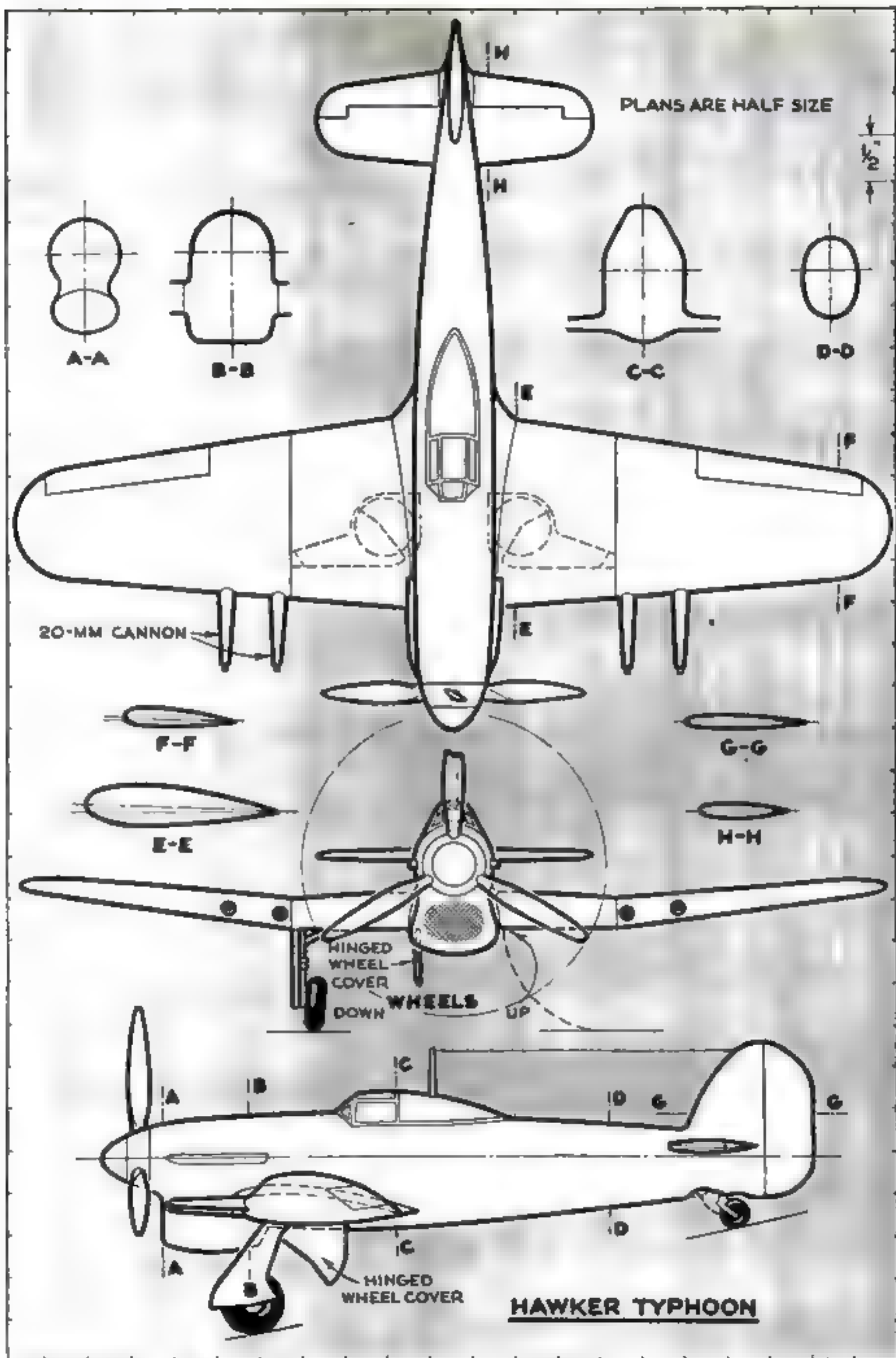
Gauge on Cold Chisel Aids in Retooling Saw

BOLTED to the blade of a cold chisel, a gauge shaped as shown from a $\frac{3}{32}$ " by $\frac{1}{8}$ " by $2\frac{1}{4}$ " piece of steel is useful in spacing and starting new teeth on a saw. Drill the hole in the chisel and drill and slot the gauge as shown. File the saw blade straight and smooth, set the gauge for the desired pitch, and strike the chisel just hard enough to make a notch in which to start a triangular file.—K. N. PARKINSON.

Tape Makes Tires Stay on Bandsaw Wheels

WHEN bandsaw tires of reclaimed rubber won't stay on their wheels, try covering them with several layers of adhesive tape of the exact width of the tires. Lap the ends against the direction of rotation so the tape won't whip off when the wheels are turning. If tires are not available for your bandsaw, several layers of adhesive tape applied directly to the metal rims will serve satisfactorily.—JOHN HUGHES.





Modeling the Hawker Typhoon

Famous British Fighter in Miniature Makes Attractive Display

THE prototype of this model proved valuable in the support of Allied ground troops during the invasion of Europe. It is powered with a Napier Sabre engine that gives a speed of 400 m.p.h. and is equipped with four 20-mm. cannons for destroying stubborn enemy pillboxes and gun emplacements.

Connect the $\frac{1}{4}$ " graduations along the borders of the half-size drawing with a series of horizontal and vertical lines to form a grid of $\frac{1}{4}$ " squares. Make a working drawing exactly twice the size of the plan with a grid of $\frac{1}{2}$ " squares. By matching squares, transfer the measurements from the small plan to the large one. From this working drawing make paper patterns of the wing, tail, and fuselage outlines to use when cutting out the blocks. Allow $\frac{1}{16}$ " extra material all around for sanding.

Use a 1" by 2" by 8" block for the fuselage, cutting away the excess wood, carving it to the proper cross-sectional shape, and finishing it by sanding.

The wing block is $\frac{1}{2}$ " by $2\frac{1}{2}$ " by $10\frac{1}{2}$ ". Note that the thickness of the wing tapers from $\frac{1}{2}$ " at the center to $\frac{3}{16}$ " at the tip. After cutting away the excess wood to bring the wing to the size of the paper pattern,

carefully shape the block to correspond with the sections; then round off the wing tips. Score the top surface and crack the wing at the points where the dihedral starts. Weight the center panel to the bench and support the tips $\frac{9}{16}$ " off the bench by small blocks. Cement the cracked portions, allow them to dry, and sand to an even finish.

Trace the outlines of the stabilizer and the fin on a piece of $\frac{3}{16}$ " wood, cut them out, shape them to a streamlined cross section, and sand smooth.

Cement the stabilizer to the fuselage, let it dry, and repeat the process with the fin. Cut the wing in half and cement each panel in position. Fill all crevices with wood putty. When the cement and putty are completely dry, sand thoroughly.

Give the entire model two coats of surface filler, sanding between coats. Paint the lower surfaces light blue and the upper surfaces olive drab, blending the edges together in an irregular line.

Finally, add the cannons and a sheet-celluloid disk to simulate a revolving propeller. Make the cockpit and control-surface outlines with black India ink. The stand can be purchased ready-made in a hobby shop or turned out in a lathe.—BILL SPRAGUE.

Below, at the left, is a close-up shot of the full-size airplane. The cigar-shaped appendages below the wings are auxiliary fuel tanks. The model, complete with its insignia and stand, is shown at the right



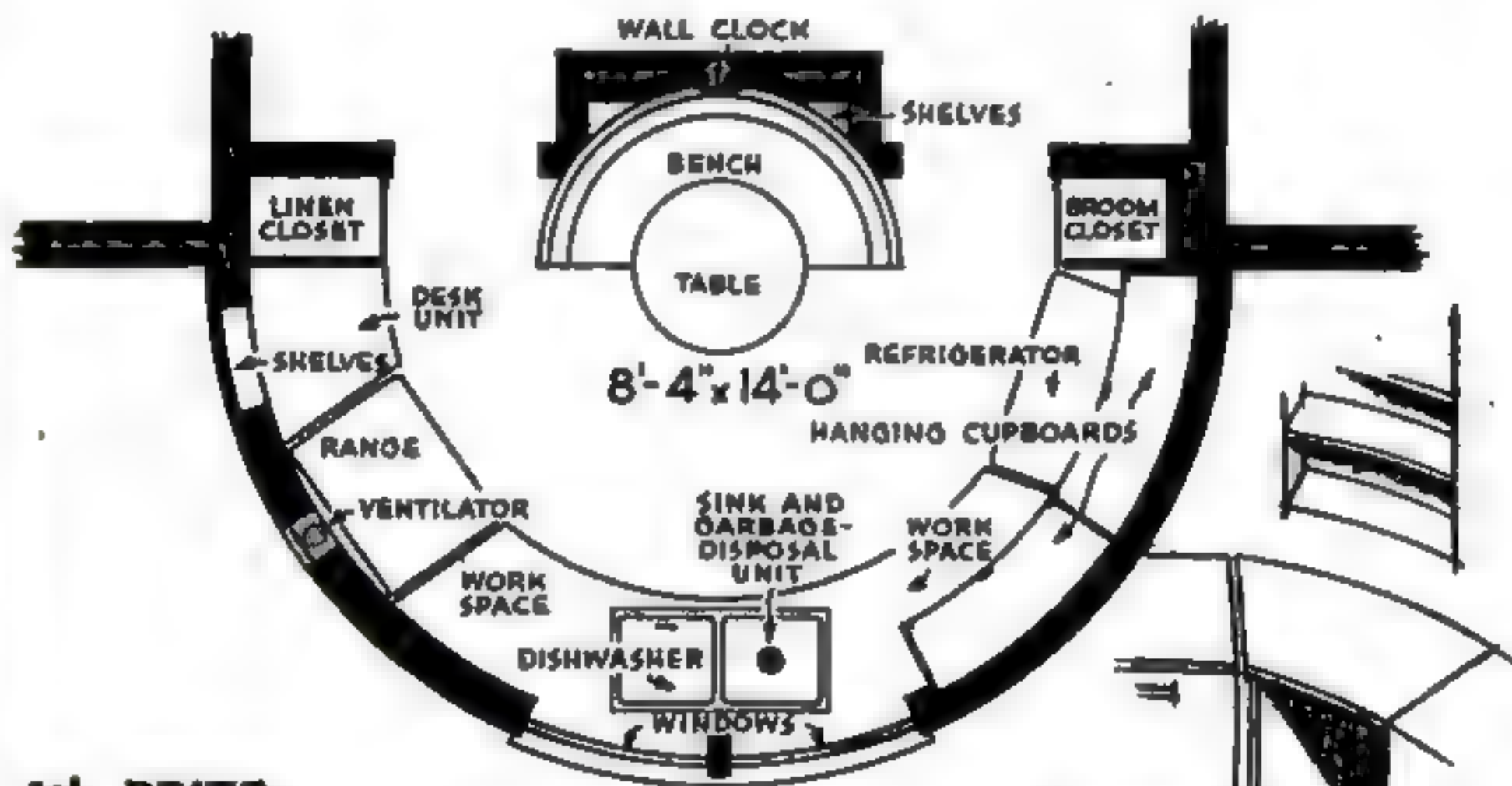
More Winners in Our: POSTWAR-KITCHEN CONTEST

SO MUCH ability and originality were shown by runners-up in the recent POPULAR SCIENCE contest for designing a postwar kitchen that four additional prize-winning entries are being presented to our readers this month. The August issue carried the plans of Mrs. Mary Lou Grace, of Ames, Iowa, Mr. and Mrs. Wayne Norton, of Muncie, Ind., and Mrs. Lillian C. Busby, of Melrose, Mass., winners respectively of the first, second, and third prize. Here are the kitchens of the contestants who captured fourth, fifth, sixth, and seventh place. Two of them were designed by women and two by men.

Below is a completely built-in kitchen, semicircular in shape, that should save steps because every bit of the working space is

the same distance from the focal point—the dining nook. Being semicircular, it also has fewer corners to clean, a point that is emphasized by Miss Elma DuFree, of Benton Harbor, Mich., the designer.

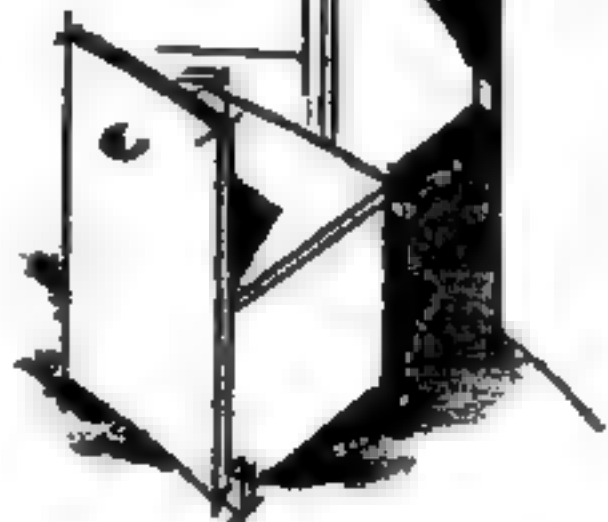
Strictly speaking, the kitchen is modern only in shape, for ultramodern equipment has been omitted by Miss DuFree and, besides the range and refrigerator, only an electric dishwasher and an automatic garbage-disposal unit are included. Laundry equipment will be in the basement. This leaves the remainder of the kitchen space for closets, hanging cupboards, work space, an interesting desk unit with a chair that pushes in out of the way, and, of course, the table and semicircular bench in the dining nook. Miss DuFree designed her kitchen



4th PRIZE

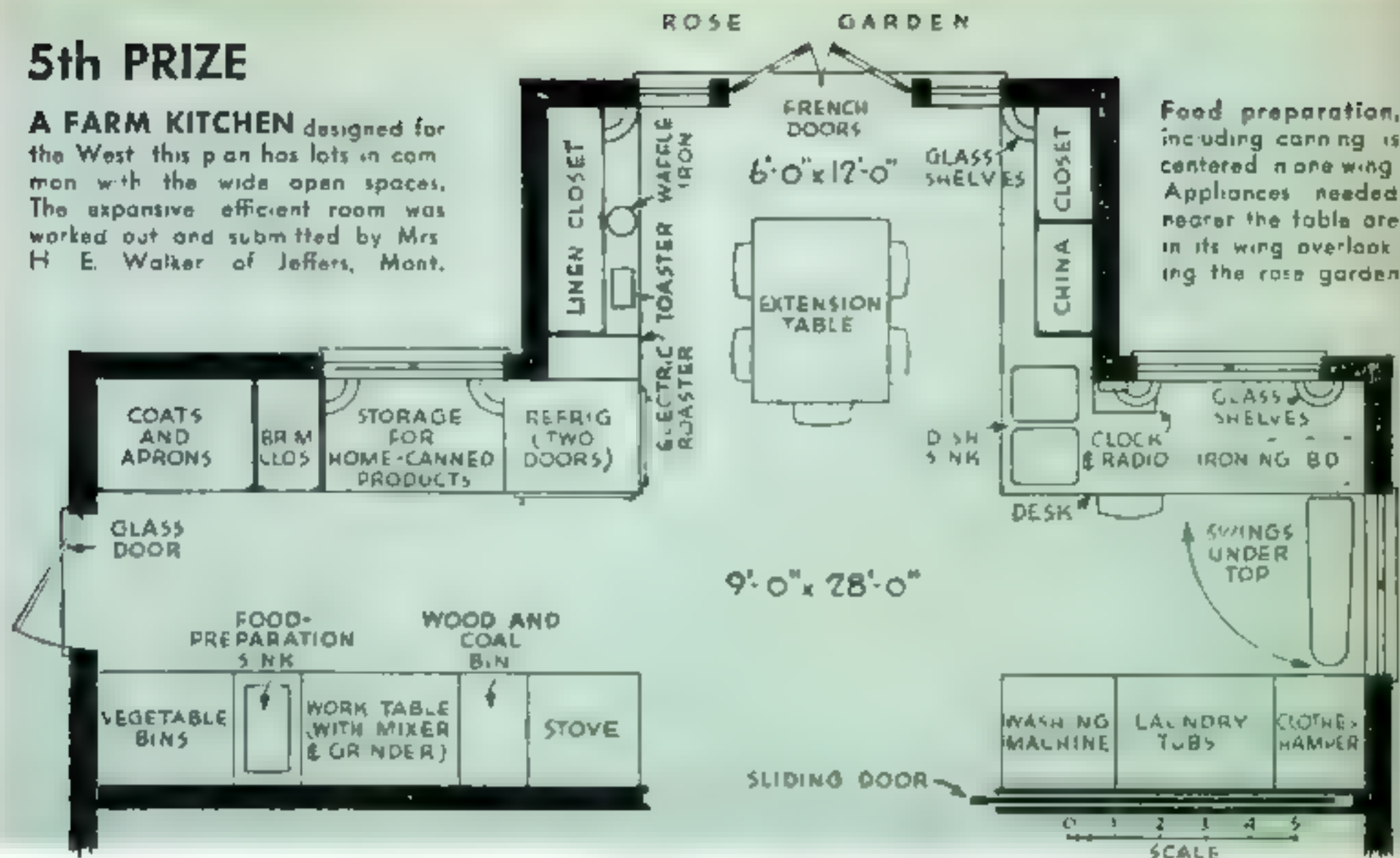
SEMICIRCULAR IN SHAPE, this kitchen is ultramodern in appearance, yet it has been kept simple, with few automatic electric units. It was designed by Miss Elma DuFree, of Benton Harbor, Mich.

Cupboards are built part way into the wall over the work space and refrigerator to give added storage depth. The refrigerator has a glass front, the range is electric, and the lighting is fluorescent. At right, the desk and chair fit into the contour when not in use.

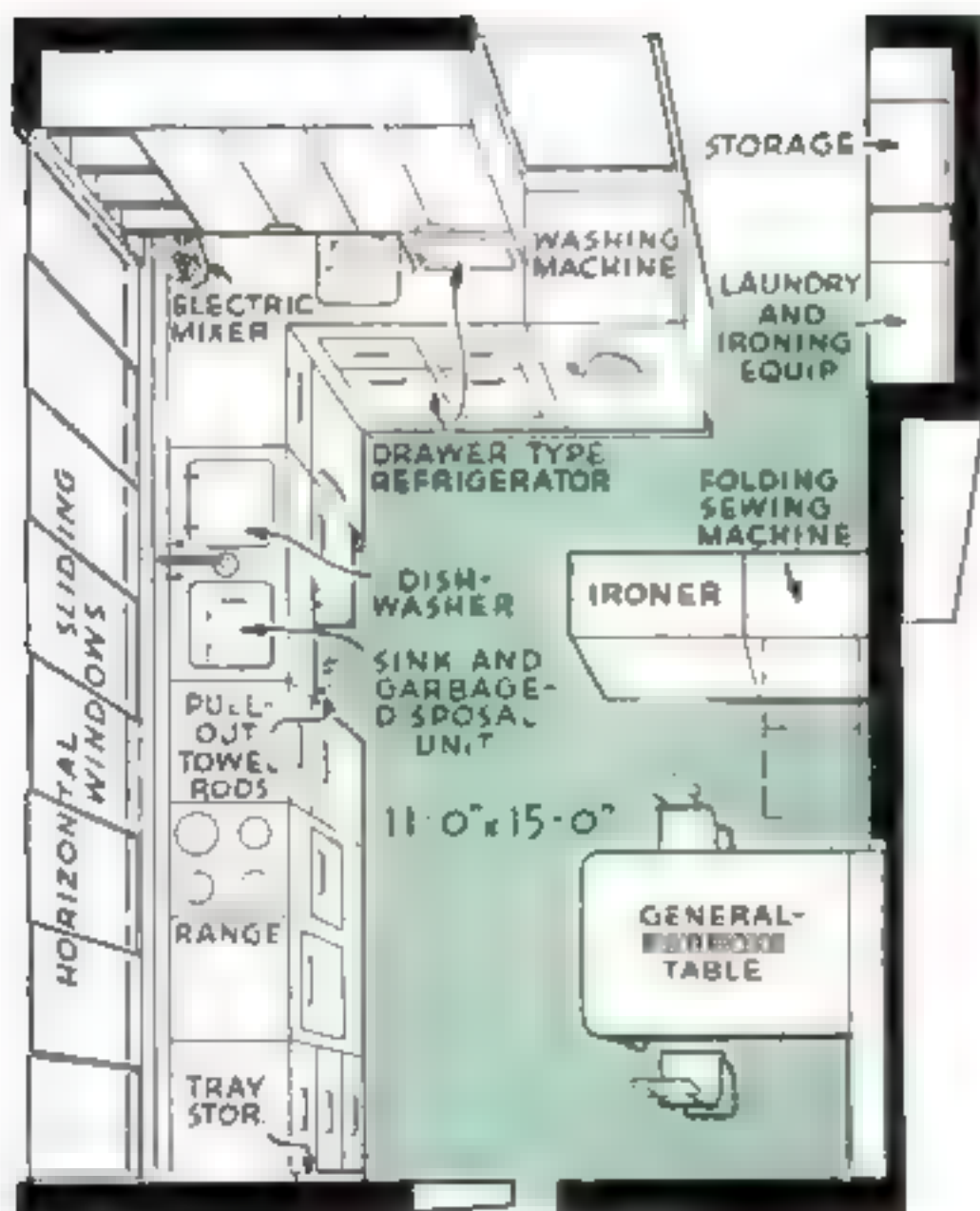


5th PRIZE

A FARM KITCHEN designed for the West this plan has lots in common with the wide open spaces. The expansive efficient room was worked out and submitted by Mrs H. E. Walker of Jeffers, Mont.



Food preparation, including canning is centered in one wing. Appliances needed nearer the table are in its wing overlooking the rose garden.



6th PRIZE

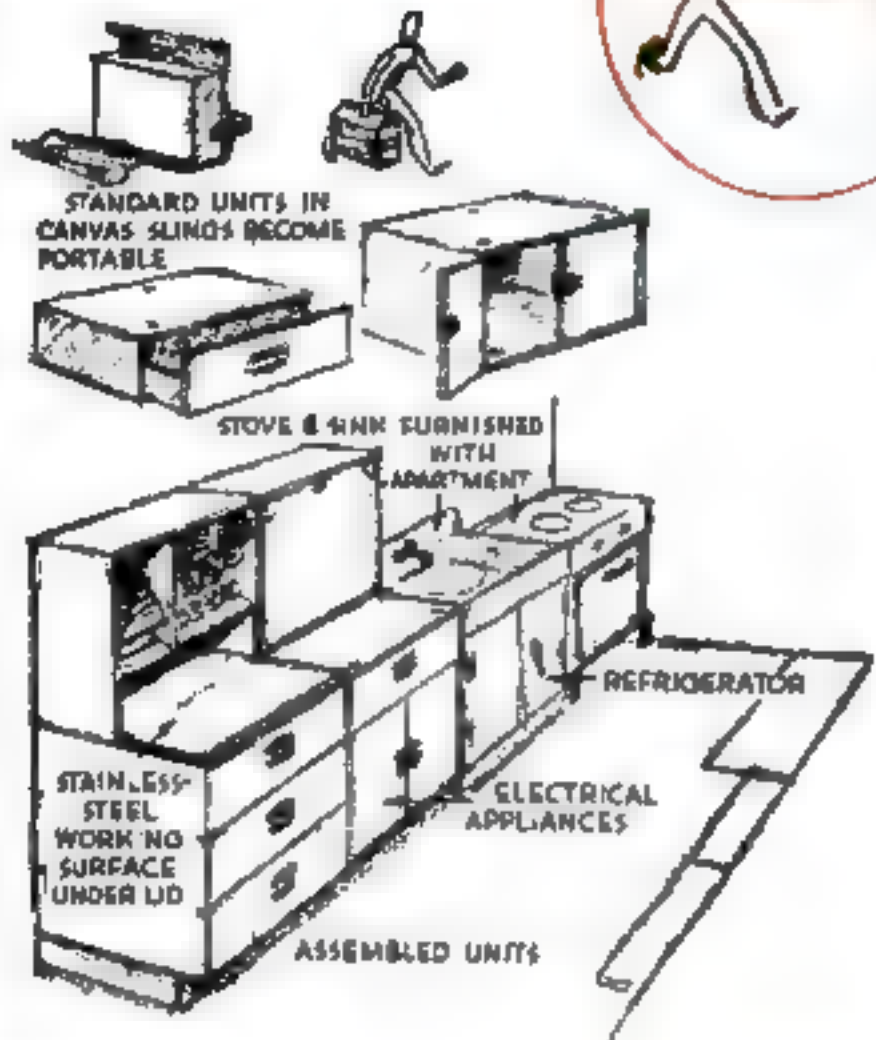
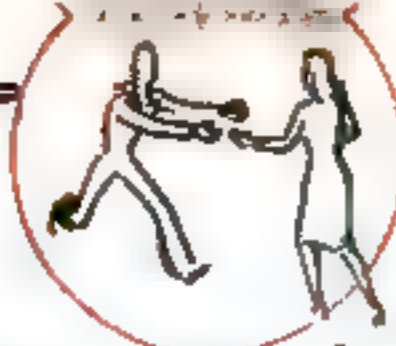
COMPACTNESS AND UTILITY are featured in this modern layout designed by Joseph Sward, of Los Angeles, Calif.

with a practical eye—it is to be part of a home she and her fiancé, an Army sergeant, are planning for after the war.

On this page are two kitchens that contrast in almost every respect, yet oddly enough they were placed next to each other when the judging was over. One, the largest kitchen entered in the contest, was designed by Mrs. H. E. Walker, of Jeffers, Mont., as a farm kitchen in the West. The other, a very compact, all-modern kitchen that includes laundry and even sewing equipment in its 11' by 15' space, is the design of Joseph Sward, of Los Angeles, Calif.

Mrs. Walker has kept her eye on beauty and efficiency as well as the wide open spaces. Her cabinets are white wood with blue linoleum tops, the ceiling is blue and is low for easy cleaning, while the floor is dark red and yellow, a tile-effect linoleum. There is storage and work space for farm canning, and room for an extension table to pull out and seat a farm crew in season.

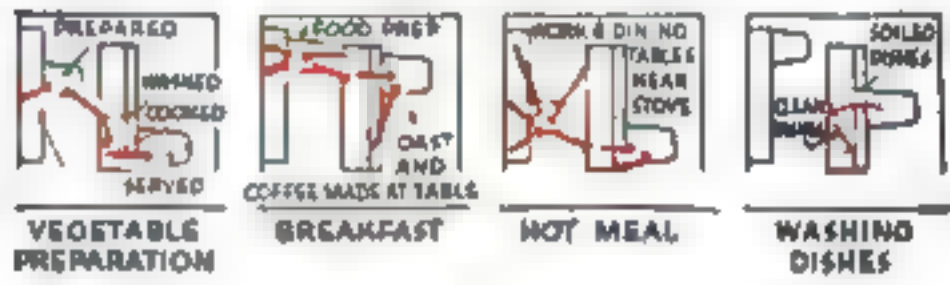
Besides the features shown on Mr. Sward's interesting plan, he



specifies fluorescent lighting, metal or plastic cabinets, exhaust grilles and a deodorizer, and sound-absorbent walls and ceiling.

Great originality was displayed by Yeoman 2/c Virgil Elsner, U.S.N., of San Francisco, Calif., who submitted not one plan, but three on this page. Yeoman Elsner intends to go into business in Chicago after the war, and his first kitchen consists of portable units that can be set up in a rented apartment. Three years after the war he expects to have his first home and a family, and has designed his second kitchen—a compact room in which work and dining tables travel on rollers and rails.

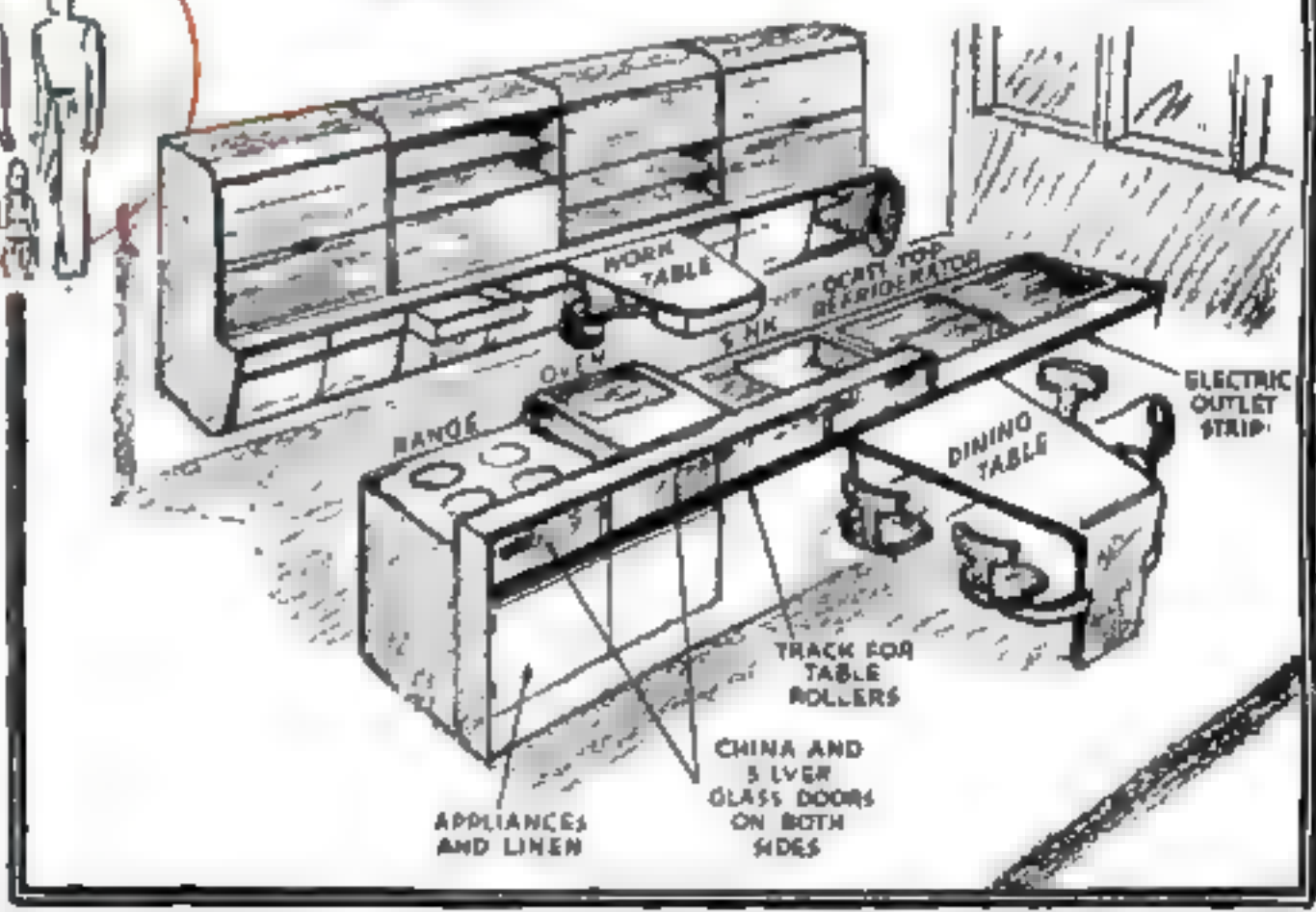
Then, seven years after the war, with family and prosperity growing, Yeoman Elsner looks for a dream kitchen in which the housewife hardly has to leave her seat to run her home. A desk and chair move on a rail around the circular room, and all controls are at the homemaker's finger tips.



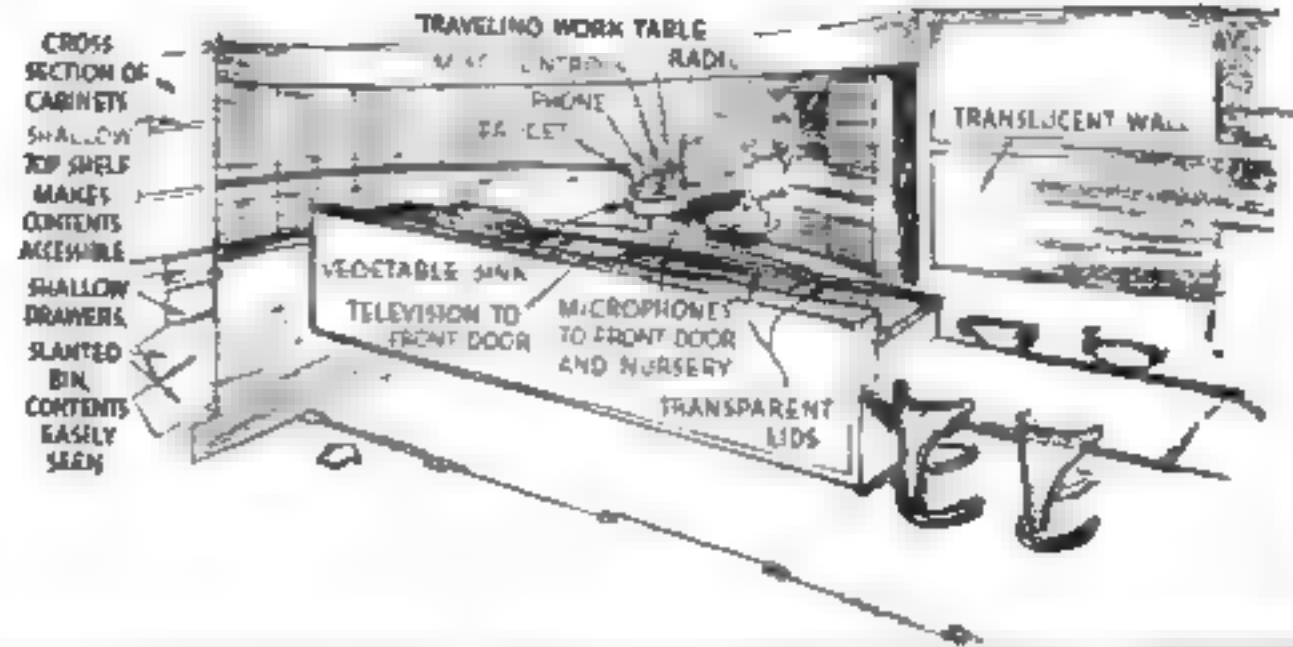
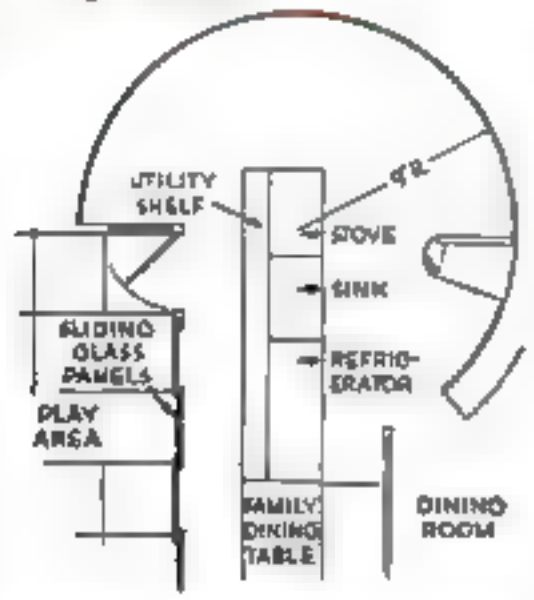
7th PRIZE

THREE KITCHENS are included in the plan entered by Yeoman 2/c Virgil Elsner, of San Francisco, Calif. A Victory model has portable units for use in any rented apartment. Later on, after the family has moved into a home, there is the modern, efficient kitchen at right. And still later (below) all the postwar dreams come true

3 YEARS AFTER



7 YEARS AFTER



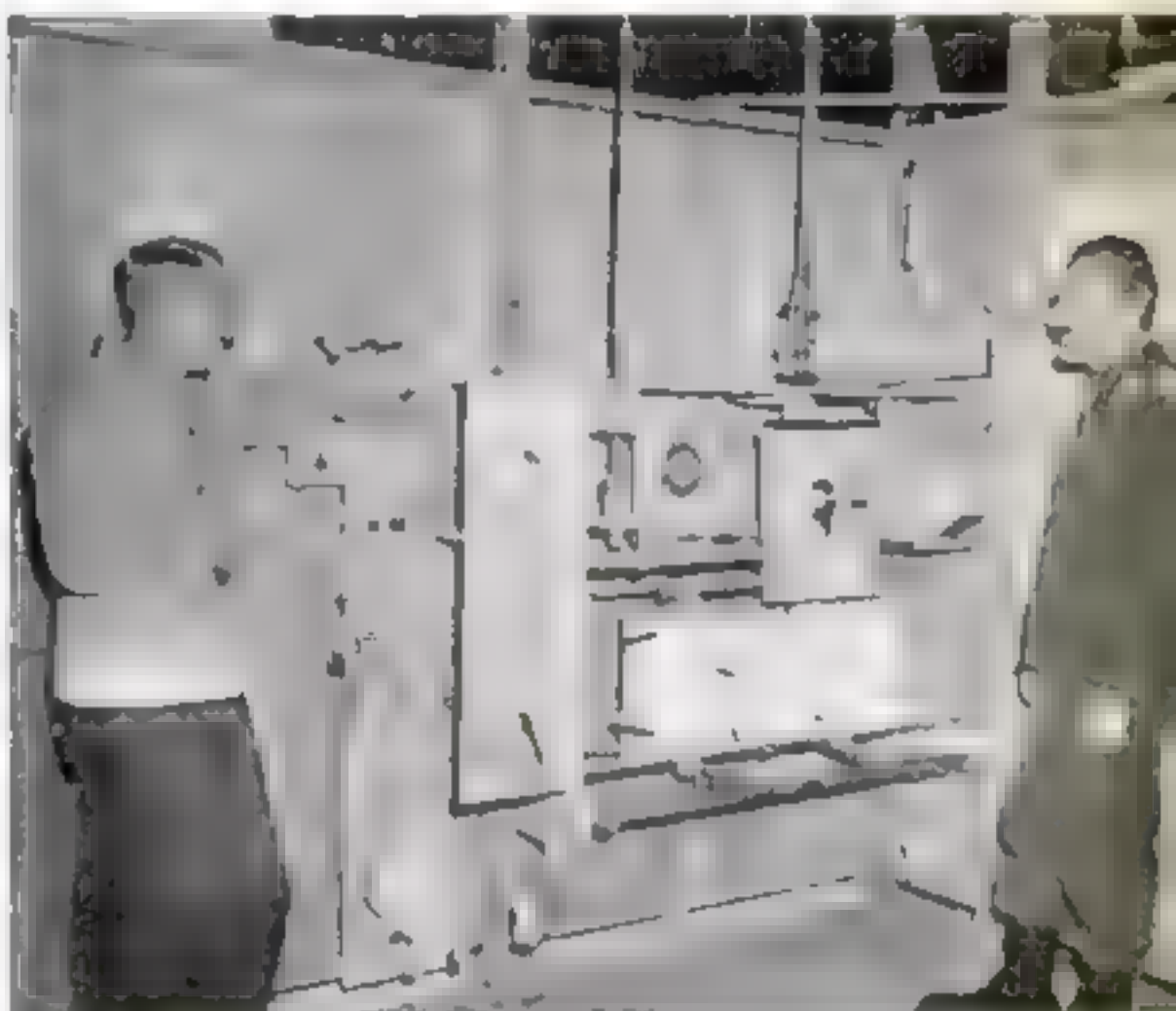
CRAFTSMEN AT WORK

BUILDING COACH MODELS is the hobby of B. J. Salamack, a New York insurance man. Here he displays a stage coach, a Concord coach, and a New York City omnibus of a hundred years ago



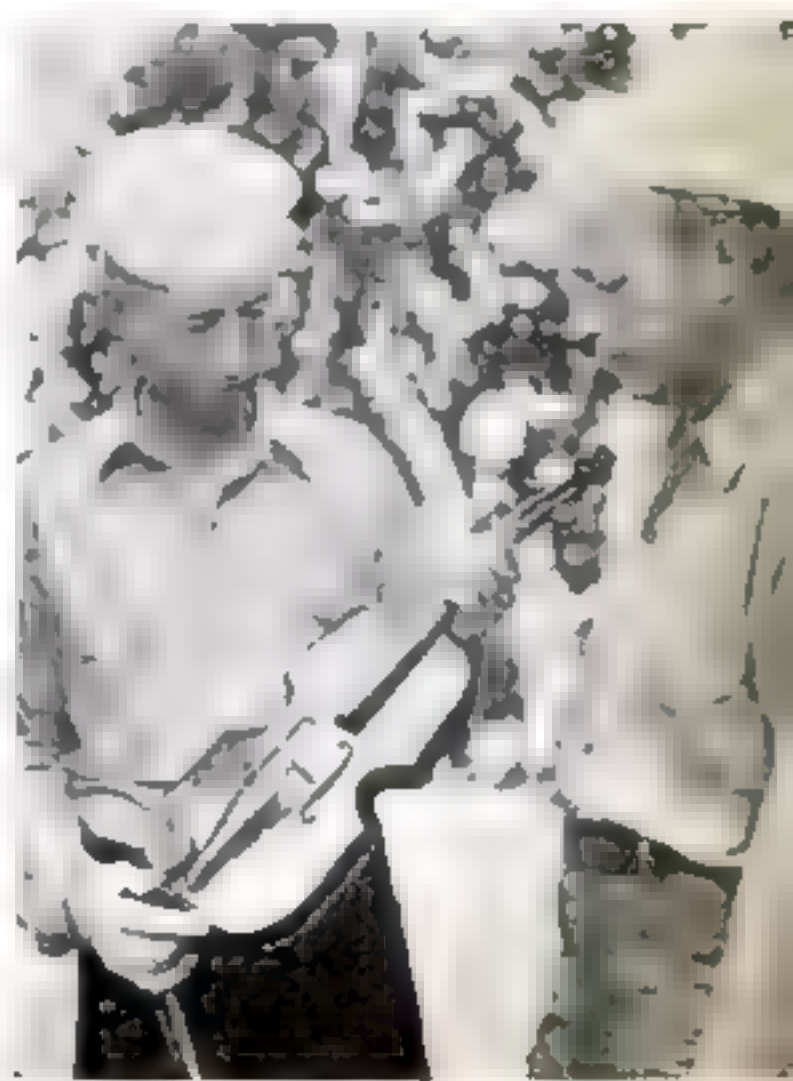
MADE FROM SCRAP METAL, this wood basket exhibited by Alvin Schulther, 9, was displayed at a Boys' Club craft show

NAZI OFFICER PRISONERS OF WAR in this country assembled the wind-and-weather station shown below from scrap material



SWEET MUSIC from Japanese war equipment seems incongruous, but 1st Lt. Walter E. Moore, of Baker, Oregon, made this banjo from pieces of a wrecked Zero and enemy bullets

IN THE PACIFIC, Travis W. Montgomery, a Seabee from Tohoka, Texas, made this violin in his leisure time from native wood, using only a coping saw, a small file, and a jockknife





Back-Yard

Exciting Little Railway Makes Ingenious Use of Skate Wheels

SAFETY, simplicity, and extremely low cost are the high lights of this home-made roller coaster, which will delight your youngsters and make them the envy of the neighborhood. Neither flanged wheels nor side-braced rails are needed to keep the little car hugging the track as it speeds along. As in big coasters, side thrust is taken by two pairs of horizontal wheels that are mounted under the car and that run against the inner sides of the rails. Since cheap, unplanned wood will do, a complete back-yard railroad can be built for very little outlay. The one shown, with an overall length of about 90', cost less than \$5.

The car should be made first so that it can be used as a track gauge. In its simplest form, it consists of a frame or platform of 1" stock about 24" long. The width, which will determine track gauge, may be from 14" to 18". At each end a 2" by 2" hardwood crosspiece is screwed on to act as an axle support. A plywood panel on the frame serves as the car floor; it should overhang the wheels sufficiently to prevent young fingers from being pinched when the coaster is in use. Plywood can also be used to form a bucket seat to help insure safety.

Eight skate wheels are required. They should be of the one-piece, ball-bearing type, and may be salvaged from a pair of skates or bought separately at a hardware store. They are held to the hardwood axle supports by 3" wood screws, which when drawn up tight will hold them on securely enough to bear the load of an adult. Use washers if necessary between wheel and wood to insure free running. Mount the vertical wheels first, locating them so that the bottom of each extends



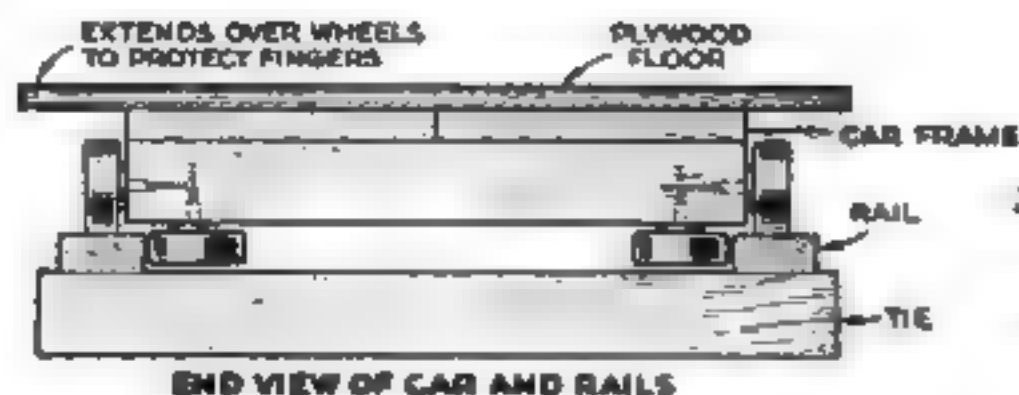
about $\frac{1}{4}$ " below the crosspiece. Then fasten on the horizontal wheels, offsetting their screws slightly so as to clear the other screws. These thrust wheels are placed with their outer edges about $\frac{1}{2}$ " from the inside edges of the vertical wheels.

Next construct the track, using 1" by 2" or larger stock for the rails and short lengths of scrap lumber for the ties. Unplanned or secondhand wood will do nicely for rails, while old pieces of two-by-four make excel-

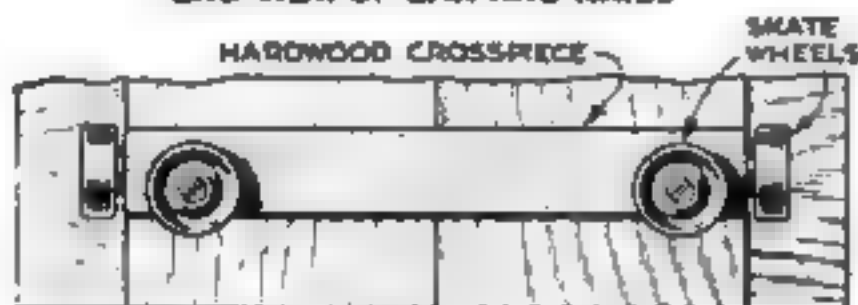
With a forward push on the lever, this lad will go rolling down on a ride both breath-taking and safe



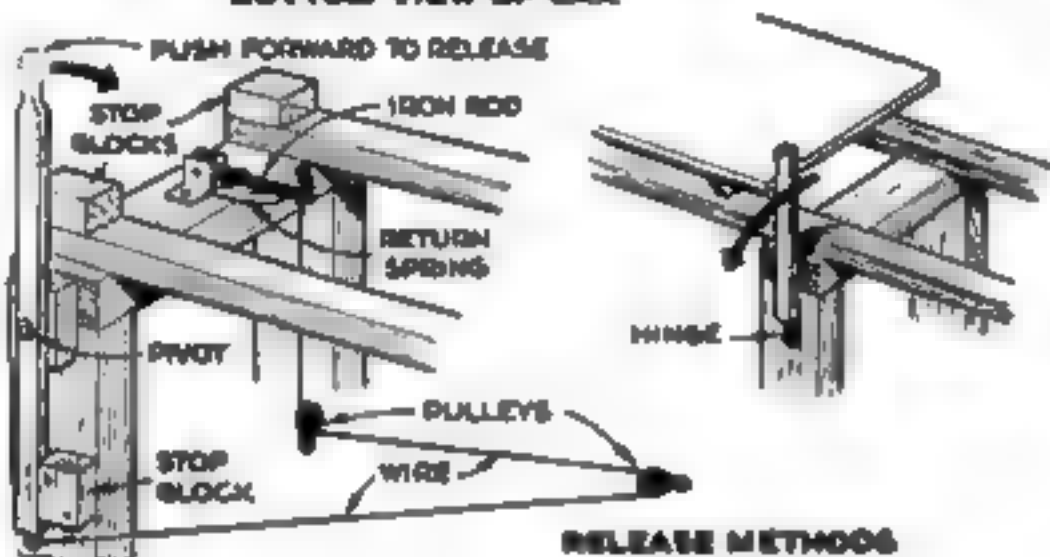
Roller Coaster



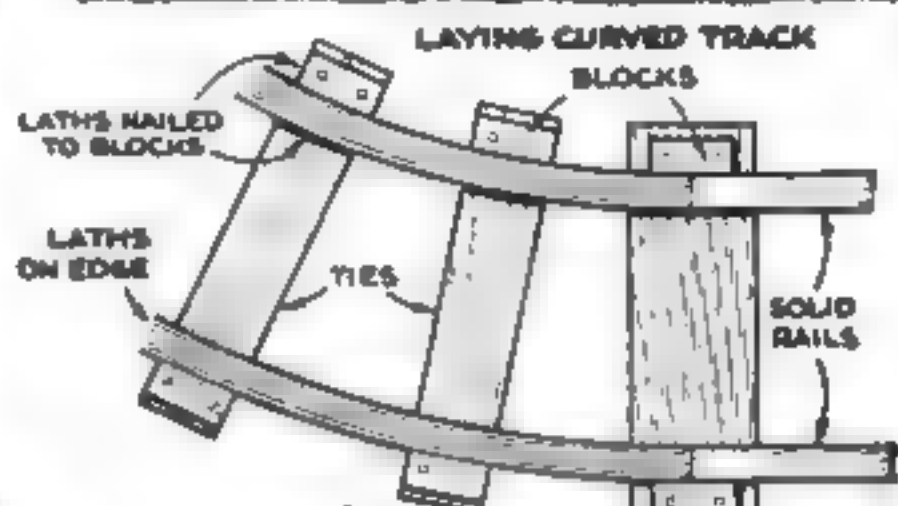
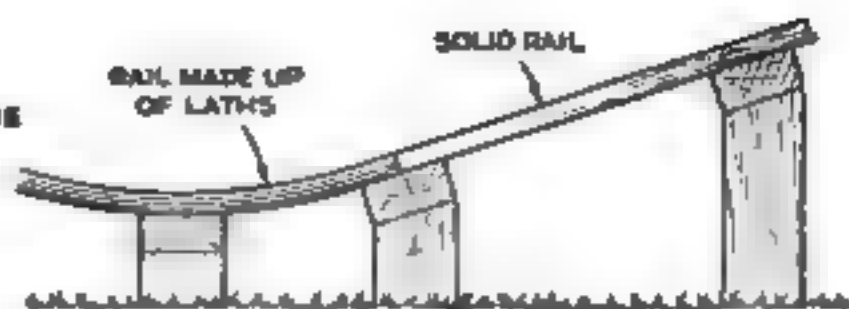
END VIEW OF CAR AND RAILS



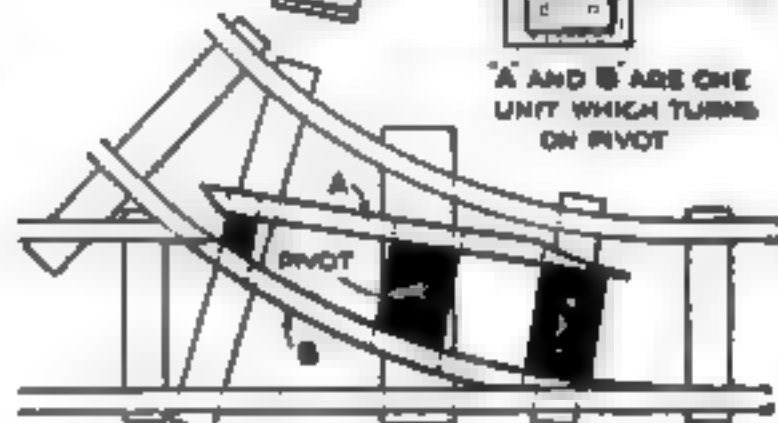
BOTTOM VIEW OF CAR



RELEASE METHOD



A AND B ARE ONE UNIT WHICH TURNS ON PIVOT



SWITCH DETAIL

lent ties. Where one length of rail meets another, butt the ends together on a wide tie. Finishing nails, driven a trifle beneath the rail surface, will cause no bumps or sound when the wheels pass over them. In measuring the track gauge with the car, be sure to allow about $\frac{1}{8}$ " side play, since less may cause the car to bind after a period of wet weather.

The track layout should naturally be designed to take advantage of a small hill, but if this isn't possible, enough speed for a good

Details of the car are shown above. The track is on an outworn ladder that is here used instead of ties

run may be achieved with an incline from a framework as little as 4' off the ground. If the first few feet of track are level or have a slight backward grade, no release device is needed to hold the car and a push will suffice to start it. However, a release mechanism may have some appeal for small passengers.

A hump or rise located at the foot of the starting incline will add a flip to the ride—but be careful not to make it more than 8" or 10" high or it may lift the fast-moving car from the rails. For both humps and curves, rails built up of laths as shown in the drawing may readily be shaped to the curvature desired. The laths should be nailed individually to the ties, or in the case of curves, to blocks that are themselves nailed to the tie. Also shown in the drawing is a switch for layouts incorporating sidings, alternate runs, or even a series of switchbacks. In making a switch, elevate the rails a little from the ties by means of thin wooden shims, so as to afford sufficient clearance for the horizontal wheels. Use waterproof plywood or sheet metal for the pieces (indicated in black) that space apart and hold the switching rails.



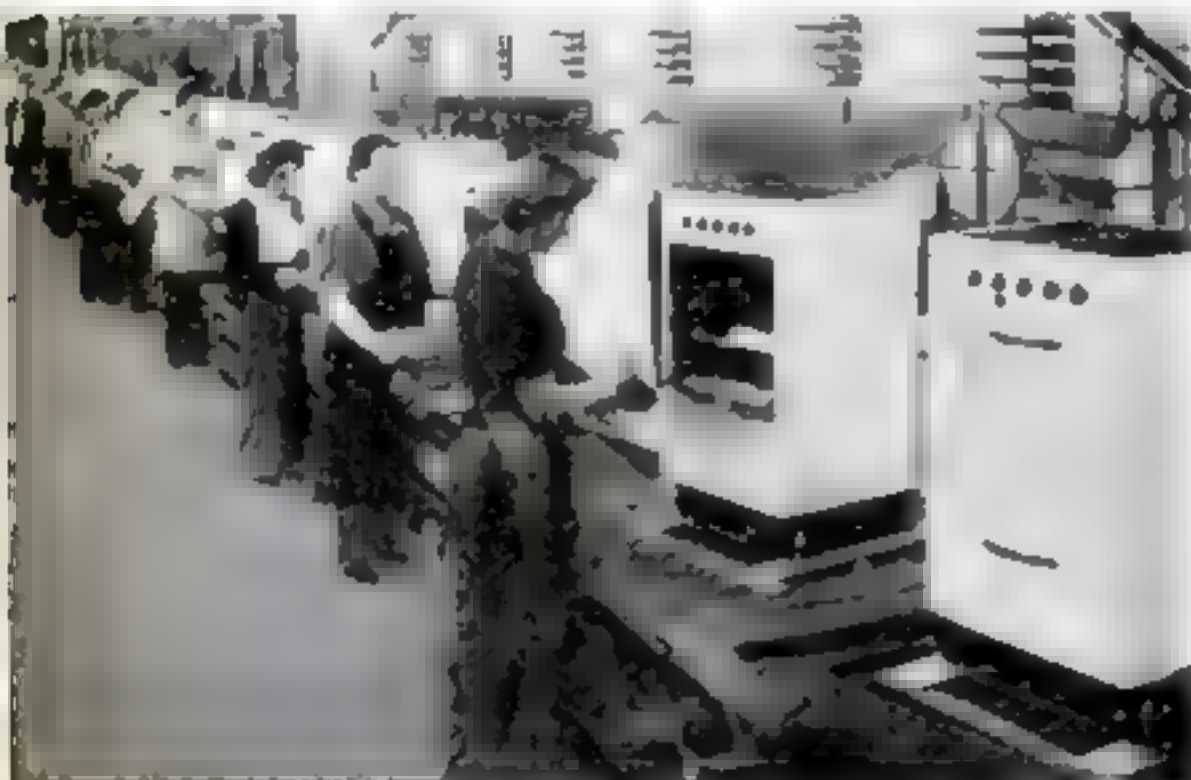


THOROUGH SOAKING of Victory gardens, flower beds, and lawns is possible with a porous canvas-duck hose coupled to the end of a garden hose in place of a nozzle and left on the ground. Water seeps through into the soil for some distance on both sides. This hose, made by the Hastings Canvas & Mfg. Co., of Hastings, Nebr., is available in 12', 18', 30', and 50' lengths.



OUTLET BOXES are being molded from plastic, providing insulation against short circuits which might result from contact between a bare wire and a metal box. The box shown at the left is a Government type made of Bakelite by the Union Insulating Company.

MASONRY WATERPROOFING that can be sprayed or brushed on is now available. It is a colorless compound that forms a transparent film over brick, concrete, stucco, or other masonry walls, filling the pores and checking absorption of dust, soot, and stains as well as moisture. Defective joints and cracks, however, require repointing before application. The material is a product of L. Sonneborn Sons, Inc., of New York.



HOME OWNERS

VITAMIN B₁ for plant food now comes in cartridges for inserting in a hose just behind the nozzle and spraying on a garden or lawn. A cartridge lasts about six minutes in the hose and will treat an area of about 30' by 50'. The V. & M. Products Company, of Galesburg, Mich., is the maker



PLASTIC FRICTION-TYPE MATTING for use as a replacement for rubber runners and floor coverings is produced by binding a friction compound with plastics. The matting, a product of the American Mat Corporation, of Toledo, Ohio, lies flat, provides a nonslip surface, and is easily cleaned. It comes in 29" by 63" sheets that can be readily trimmed. The color is jet black.

NEW KITCHEN GAS RANGES, a number of which have been authorized by the WPB, are now being turned out by the Norge Division of Borg-Warner Corporation, of Detroit. The ranges are 20" wide by 36" high, are made of steel with rock-wool insulation, have a white porcelain finish, and are supplied with four burners. They are described by the company as not a Victory model, but one that will be continued after the war. Certificates from local ration boards are required for purchasing. The women shown at the left aren't making biscuits—they are making the ranges.

Glass Sandwich Takes Place of Storm Sash and Window Pane



Insulated glass made of two panes bound together by an airtight copper seal and enclosing a thin dead-air space will keep a house like that shown above or the room at right comfortable in winter. A section of this new glass is illustrated below

INSULATING glass less than $\frac{1}{2}$ " thick now combines the functions of both window pane and storm sash. It is a double glass, bound around the edge with an airtight copper seal, and sandwiching between the two panes a thin layer of dehydrated air. Being a fixed unit, it may outmode storm sash in postwar dwellings, and it may save fuel in skyscrapers where installation and removal of storm sash is impractical. The new glass is likely also to find favor in climates where storm sash is not normally needed in winter, but where daytime insulation of windows would be a big help in keeping a house cool in the summer.

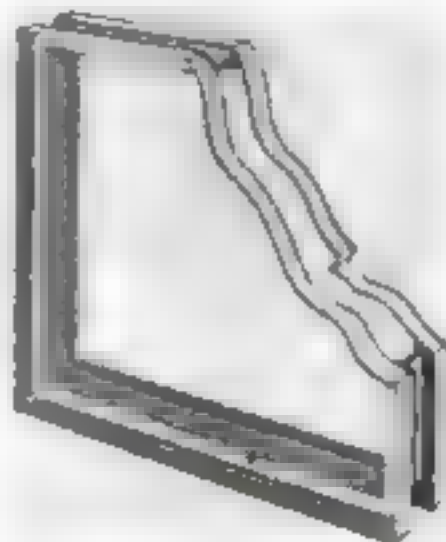
Insulation is provided in the same manner as is insulation with ordinary window panes and storm sash, with the exception that the dead-air space between the two panes of the new glass cannot leak and the air in it will insulate better by always remaining "dead" and dry. The dryness of the air prevents frosting of the outside pane, such as occurs on storm sash and on window panes used without storm sash. The insulated glass has been shown to screen out mixed noises 20 percent more efficiently than a single pane can. Double reflection because of the two panes has been found to cut down vision about 8 percent more than that through a single pane.

In recent tests by the Libbey-Owens-Ford Glass Company, of Toledo, Ohio, which manufactures the insulated glass, a



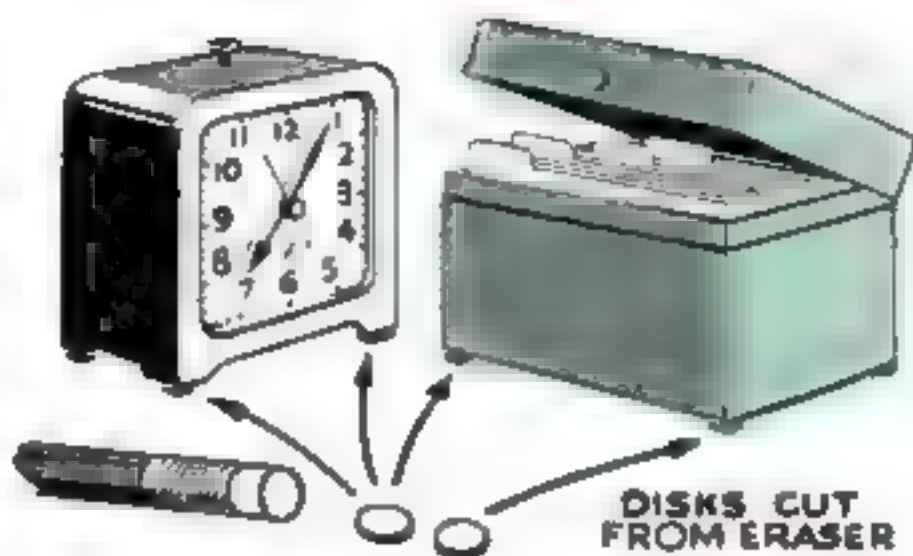
unit installed in a laboratory "cold box" showed a 20-deg. difference in temperature on its cold and warm sides, while a single pane also installed in the box showed a difference of only 1 deg. The photographs on this page are of a modern home equipped with the new glass, and they indicate a type of "open plan" architecture the glass may make possible in cold climates.

Tanks and airfield control towers have already been fitted with the glass, insuring clear vision in rain and snow, and Signal Corps trucks also have been provided with it as a protection for delicate instruments that still affords truck personnel unhampered vision. Because the glass requires a sash thicker than the standard for single panes, civilian use is unlikely until after the war.

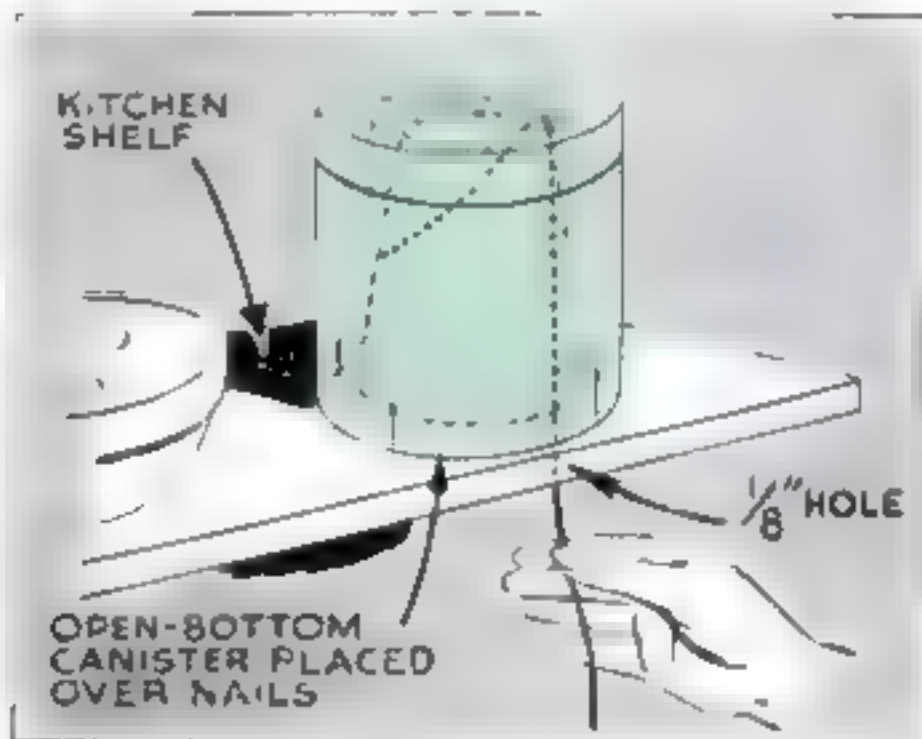




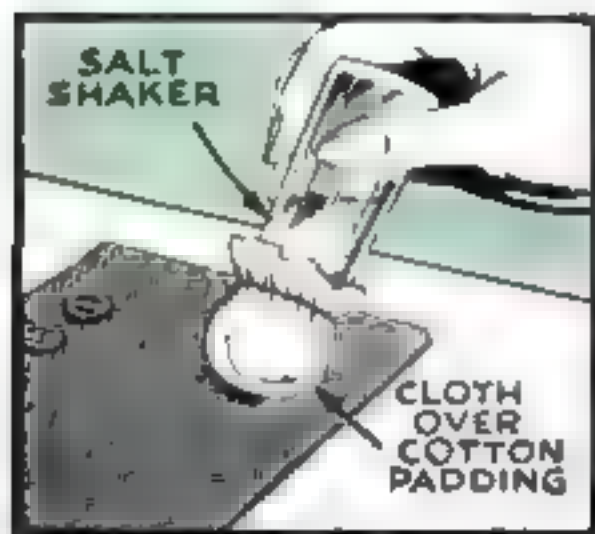
Waste space beneath the skirts of a boudoir chair may be used for storing a shoehorn, as indicated above. Hang the shoehorn on a hook that is screwed to a leg of the chair. A stiff-wire suede brush may also be kept there, on a hook or a nail, if it has a screw eye driven into one end of the back



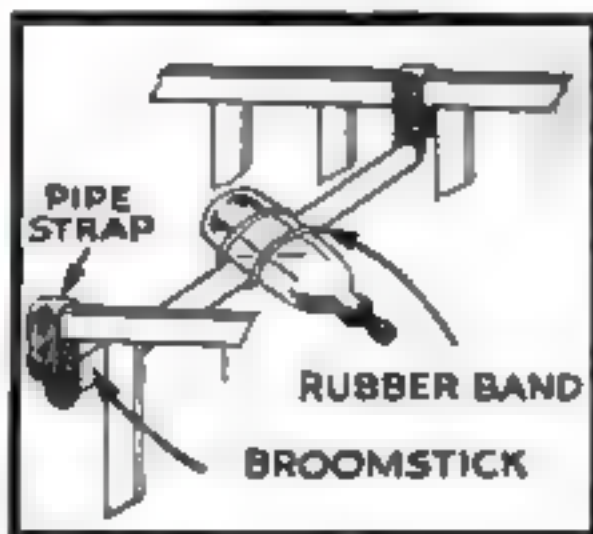
Small rubber disks, sliced from pencil erasers and glued to the bottoms of clocks, stapling machines, card files, and similar articles, act as vibration dampers and protect your furniture from scratches



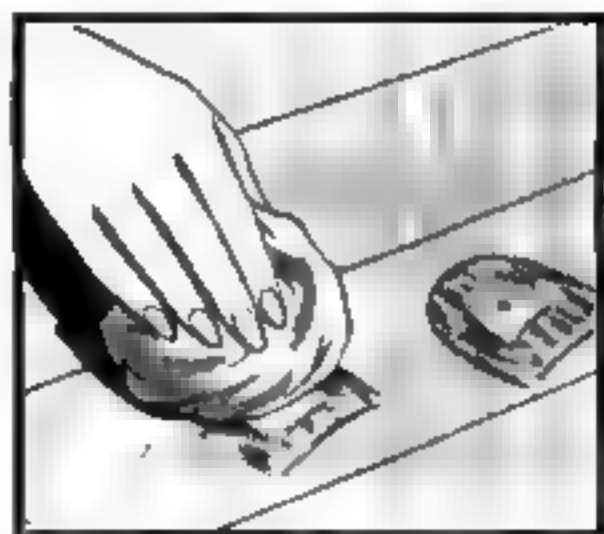
Spools of string, held in brackets that may be bought, are handy for kitchen use. To prevent the string from becoming dirty, put it and the holder in an open-bottom canister that is held in place on the shelf by three or four brads. Bore a $\frac{1}{8}$ " hole in the shelf for the string to pass through



This cleaning-fluid dispenser is made from a cloth-covered cotton pad tied to a salt shaker

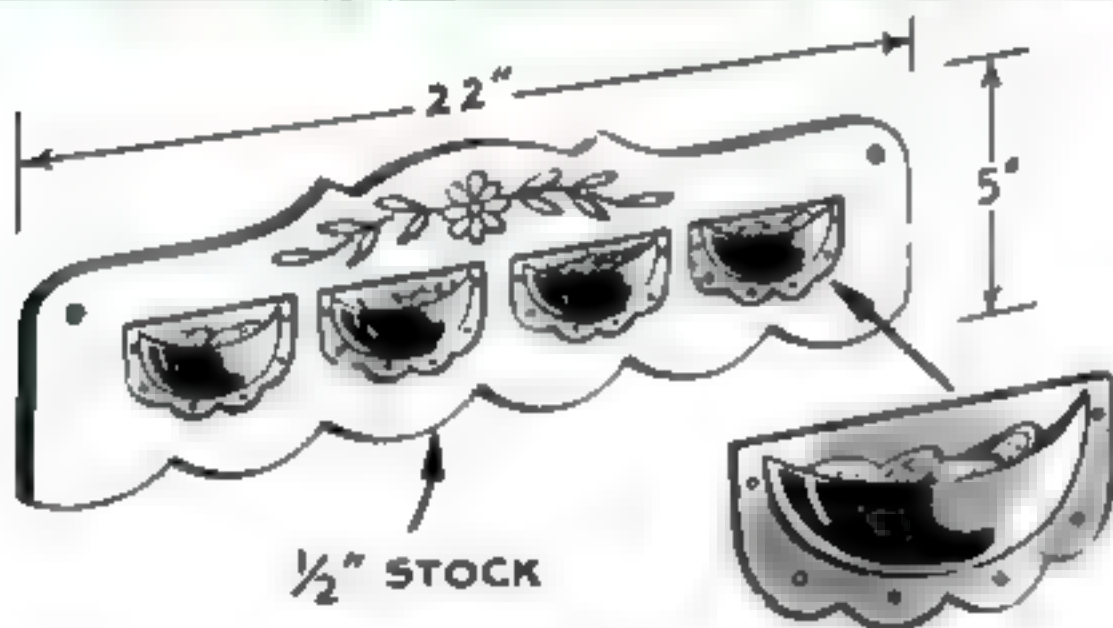
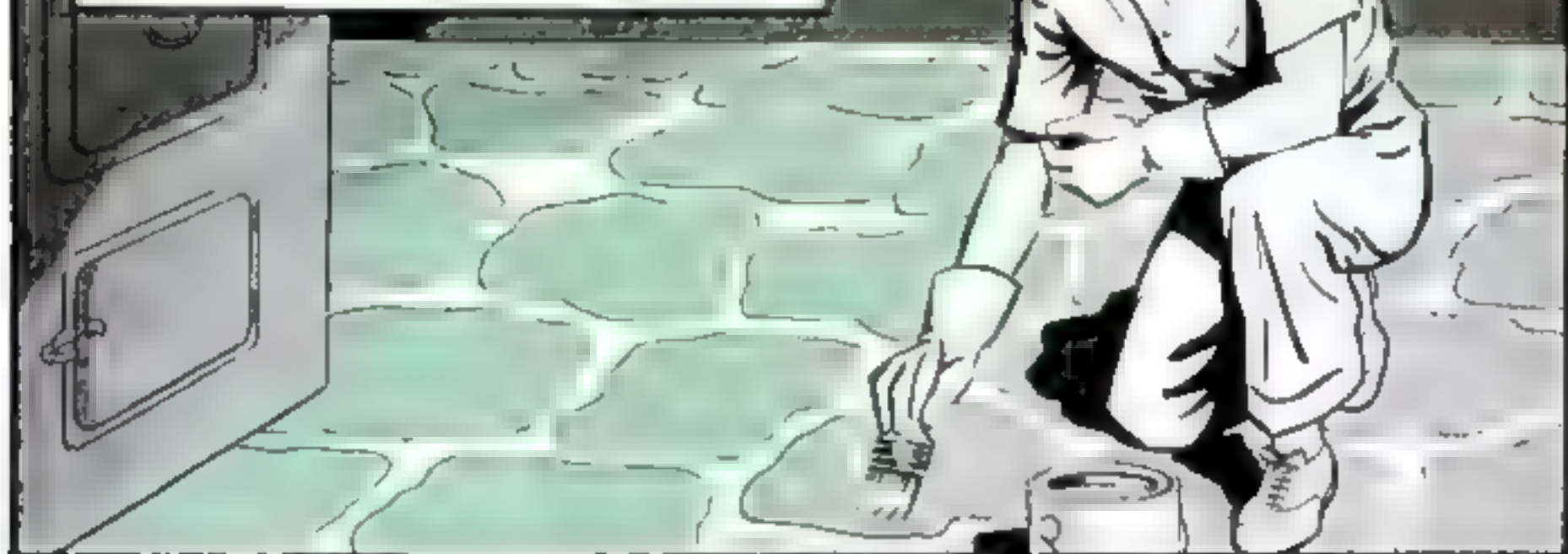


Easy to make and adjustable, the baby's bottle holder shown above is hung from the sides of a crib

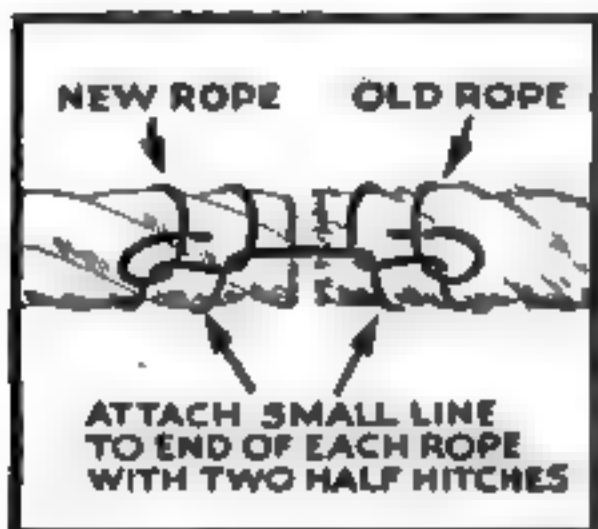


Marks made by rubber heels on waxed floors may be eradicated with a turpentine-dampened rag

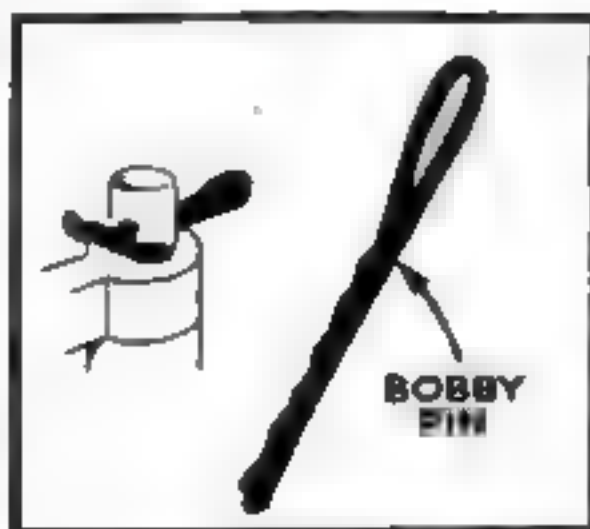
Pseudo-flagstones, painted on a concrete cellar floor, form a novel patio design. Apply a waterproof base coat; then, with floor enamel in various colors, paint in the flagstones. This method abviates the refinishing of the complete floor at one time. Deviations in tone are to be desired rather than deplored, so left-over enamel can be mixed to obtain different shades



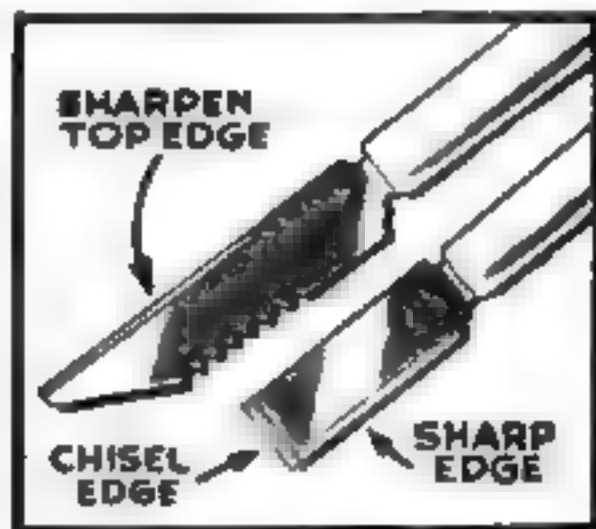
This simple, handy wall fixture will hold pins, buttons, nails, and other small items that otherwise might be easily mislaid. It is made from four inverted brass drawer pulls and a 5" by 22" board. Polish the pulls to a high luster and give them a coat of clear lacquer. Finish the board with bright enamel and, if desired, a decal transfer or some gay peasant pattern



To run a new rope through a block that is hard to reach, tie it to the old rope as indicated above



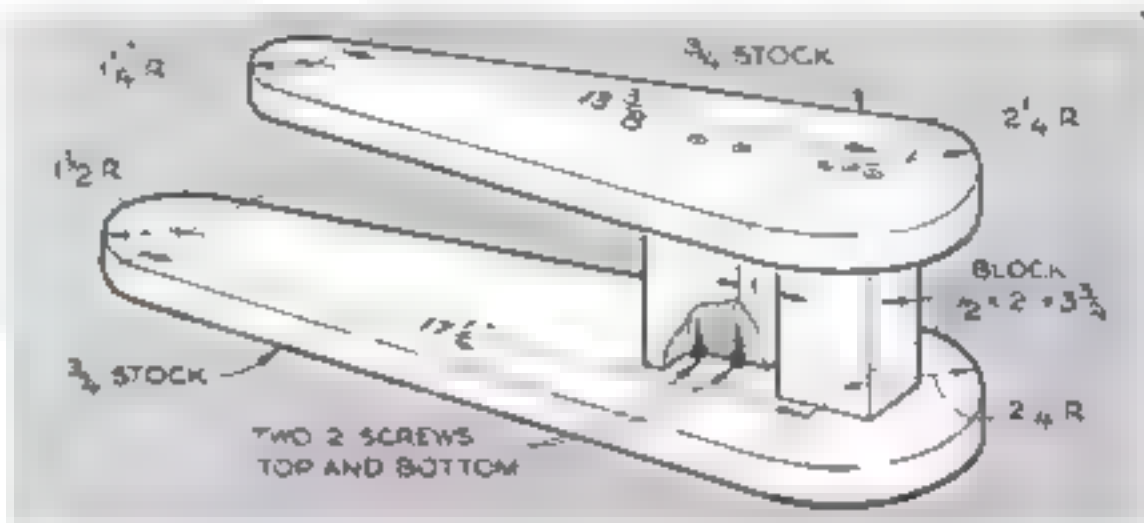
In an emergency, a bobby pin can be used as a substitute on light linkage for a missing cotter pin



Old table knives can be ground for special needs, such as cleaning fish (top) or removing putty

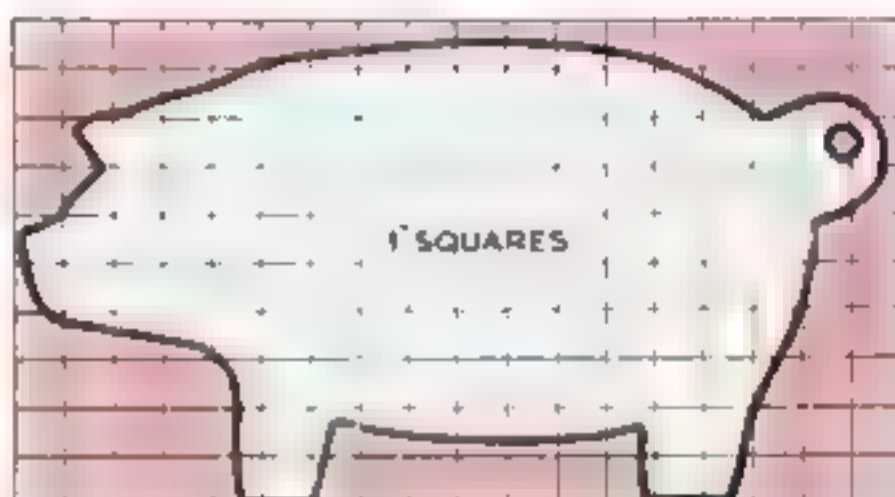
Simply Built Ironing Board Is Handy for Pressing Sleeves

WHEN sleeves and shoulders are to be pressed, a sleeve ironing board is practically a necessity. One can be made easily from two $\frac{3}{4}$ " by $4\frac{1}{2}$ " pine boards and two hardwood blocks, as shown. Connect the outsides of circles drawn to the radiuses indicated, and saw along these lines for the top and bottom; then lay out and bore in each four screw holes slightly smaller than the screws, line up and drill the blocks, and assemble. Cover the top, or shorter piece, with several layers of old blanket or other padding and a strip of heavy, unbleached muslin tacked securely under the edges.—N. E.



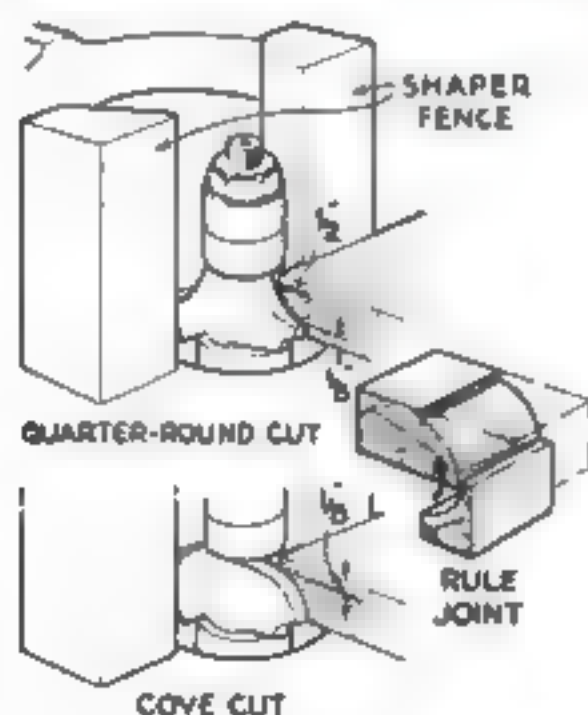
Slicing Board Shaped Like Pig

LAY out the pig outline on 1" squares and transfer it to a 10" by 18" scrap piece of $\frac{1}{4}$ " or $\frac{3}{8}$ " plywood for sawing out this useful slicing board. Bore the hole in the tail for hanging; then sand the edges smooth and sand the top and bottom sides lightly. For a protective finish that leaves no added taste on meat, bread, or cheese, rub in cooking oil or lard.—FRANCIS L. TYLER.



SHAPING A RULE JOINT

[WOODWORKING]



Work the quarter-round cut on the table top and the cove on the drop leaf. Material is usually $\frac{1}{4}$ " thick, but thicker or thinner stock can be used if the hinge pin is centered on the curve of the mold. Since most home-workshop shaper cutters will not make quarter-rounds larger than $\frac{1}{4}$ " radius, gauge lines on the ends of the table top, as shown in the drawings, and use the intersections for adjusting the height of the shaper cutter and to locate the fence. Lay the face surface of the top on the shaper table for cutting. The molding may be made on the ends also, but if it is, gaps will show at the ends when the leaves are down.

Lay the leaves on the shaper table with the face surface up and measure down slightly less than $\frac{1}{4}$ " for cutting the coves in order to give clearance on the quarter-rounds after assembly. If the cutters are taken from the same set, no change in setup will be needed except to change to the cove cutter.

POPULAR SCIENCE MONTHLY SHOP DATA



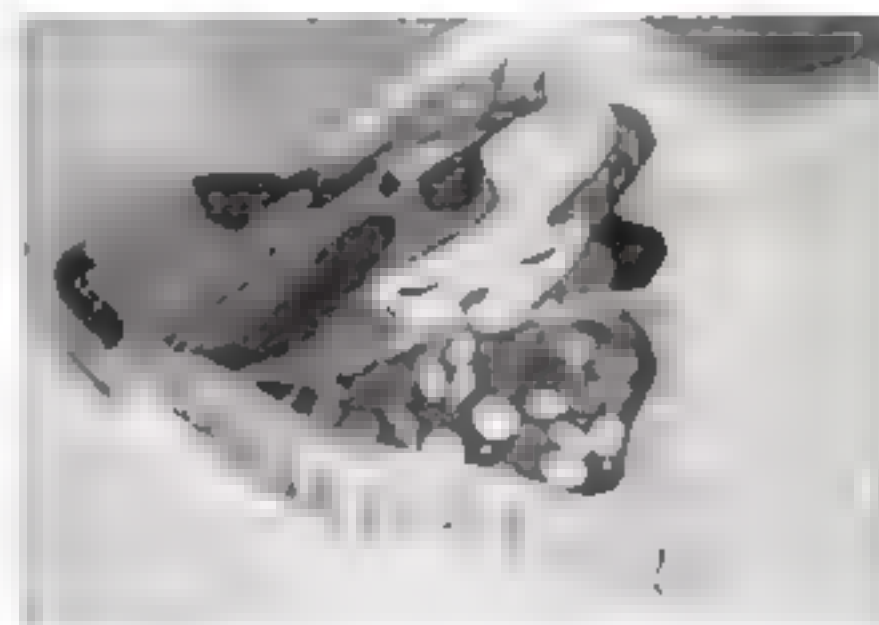
Animal Cutouts Adorn the Lids of Novel Boxes for Children

COLORFUL boxes to hold candy, crayons, or trinkets for children can be made with cutouts from Mother Goose, animal books, or magazines. Those having fairly smooth outlines make the work easier.

Sandwich a piece of $\frac{3}{8}$ " to 1" stock between two sheets of plywood or composition board, the top piece being first sawed into two parts for a hinged lid, and tack the setup together lightly. Attach the cutout with thumbtacks, handling it carefully to keep from tearing or soiling it; then draw the outline and remove the cutout.

Next, saw the outline with a jigsaw or coping saw, take the pieces apart, and saw out an inside section of the middle piece to suit the contents the box will hold. The photo at left shows all the pieces before final assembly. Glue or nail the bottom, center, and smaller piece of the top together. At-

Plywood can be used for both the top and bottom of the box, while the body is made of thicker stock



tach the other part of the top with linen tape for a hinge, affix a catch of soft leather or elastic that can be stretched over an escutcheon pin, and paint the edges, if desired. Finally, glue the picture carefully to the top.—BERTRAM BROWNOLD.

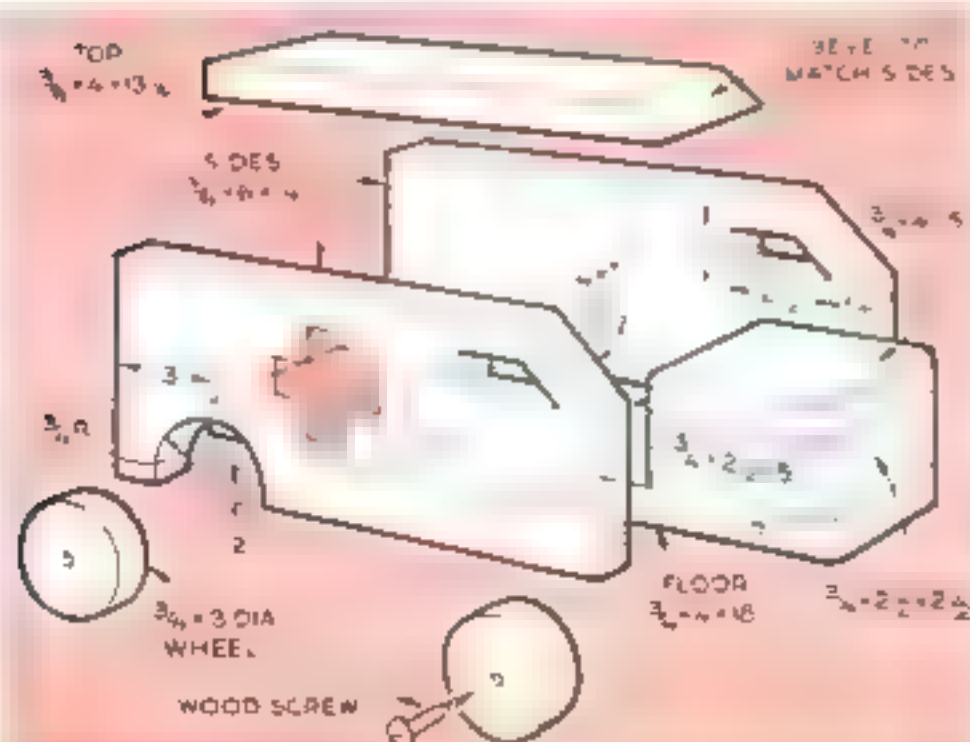
Sturdy, Attractive Toy Trucks Are Built Entirely of Wood

USING the simple method of construction illustrated in the drawing, and designing the body to suit the type of truck desired, you can make a fleet of toy trucks that will be sturdy enough to stand rough treatment.

Cut the floor, hood, and top from $\frac{3}{4}$ " stock 4" wide, and the sides from $\frac{3}{4}$ " stock 6" wide. Bevel the front of the top to match the bevel of the sides for an ambulance of the type shown below. The hood is built up

of four pieces. Large upholstery tacks make headlights.

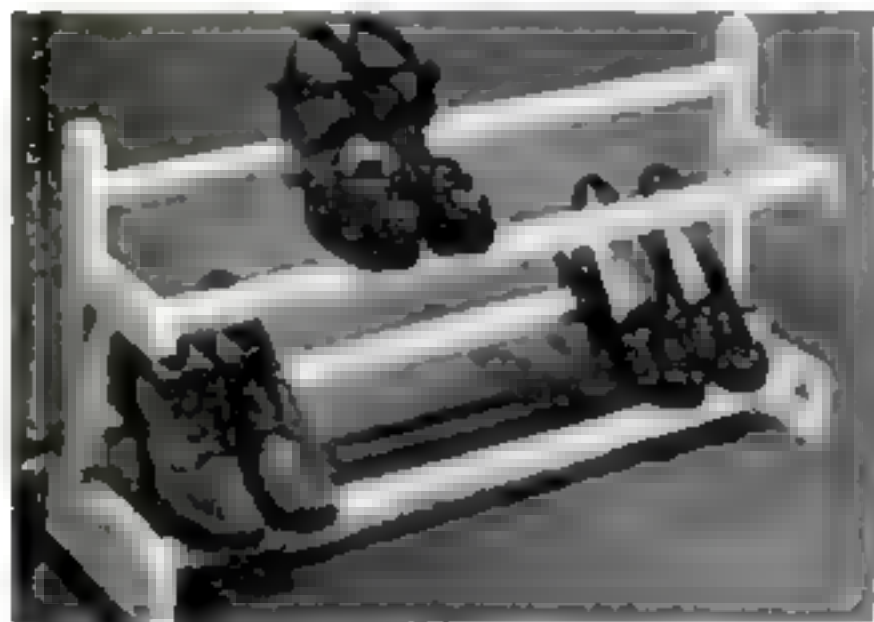
Wheels are turned from stock of the same thickness as the sides, or they can be made by taking tangent saw cuts along the outside edge of a circle and rasping and sanding the corners round and smooth. They are attached with wood screws driven in 2" from the front end of the floor and 3" from the rear.—CARL W. THOMPSON, JR.



What's New in Modern Living



WITH A NET TOP AND SNOOD, an airy rayon cap shown by the Greater New York Safety Council will keep a woman war worker's hair from being caught in machinery.

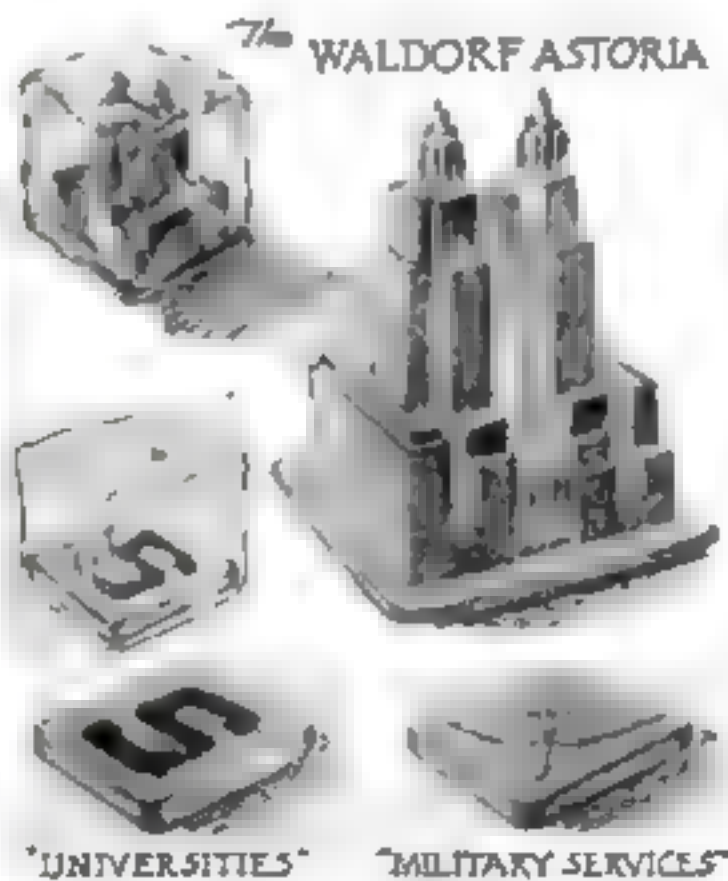


THIS FLOOR-TYPE SHOE RACK is useful near a vanity or in a closet. It is made by Met-L-Top Tables, Inc., of Milwaukee.

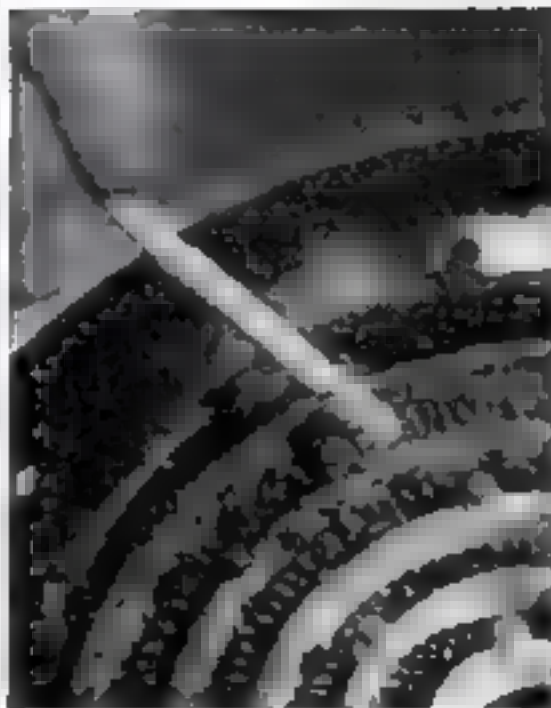
METAL ADHERES TO METAL with the application of a synthetic-resin base cement now available. Developed by the American Wood Type Mfg. Co., of New York, it is used also on leather, paper, wood, and viscose and acetate sheets. It is milky white on application and transparent when dry.



LIGHTWEIGHT LUMBER taken from the ornamental paulownia, may soon be used for crating and boxing articles to be shipped by plane. This tree, known also as the empress tree, is a native of the Far East and has been planted in America chiefly as a flowering shrub. Its wood has a fairly coarse grain, glues up well, resists warping, and has considerable strength. A cubic foot weighs 14 to 19 lb., about twice the weight of balsa and half that of white pine.

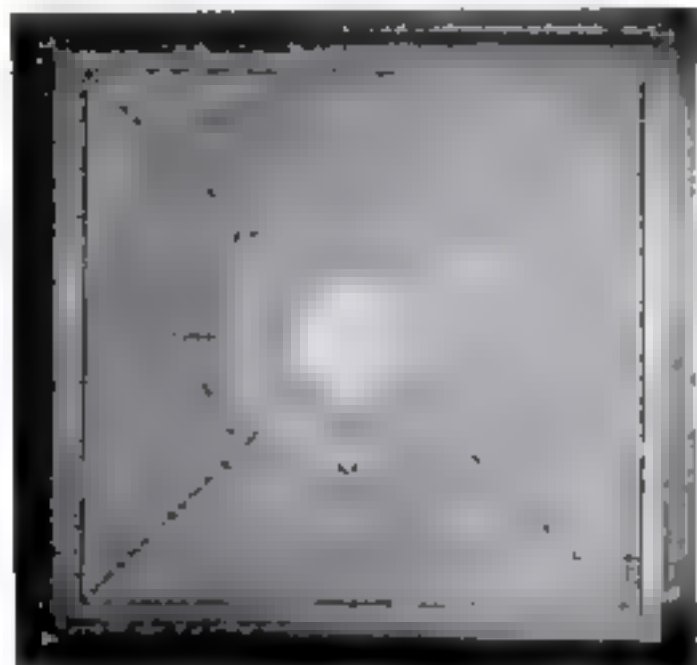


ICE CUBES SINK to the bottom of a beverage glass and stay there when they are frozen around colorful sinkers. Molded from plastic, metal, glass, and ceramic material, these sinkers may be on the market soon in the form of buildings, like the Waldorf-Astoria model shown at the left, and other novelty designs, and as simple blocks with initials or military and similar motifs. For freezing, they are put in the ice tray, and water is added. The patent is held by Linden & Company, of Los Angeles.



REPAIR OF ELECTRIC ELEMENTS is almost automatic with the addition of a new welding flux in powder form. As shown above, the ends of the broken element are joined and held pressed together by a dampened matchstick that has been dipped into the

flux. The current is then turned on, and the heat welds the break. Electric stoves, toasters, and other appliances having elements of the resistance-wire type illustrated may be similarly mended. The flux is the product of the Chanite Sales Co., of Fort Worth, Texas.



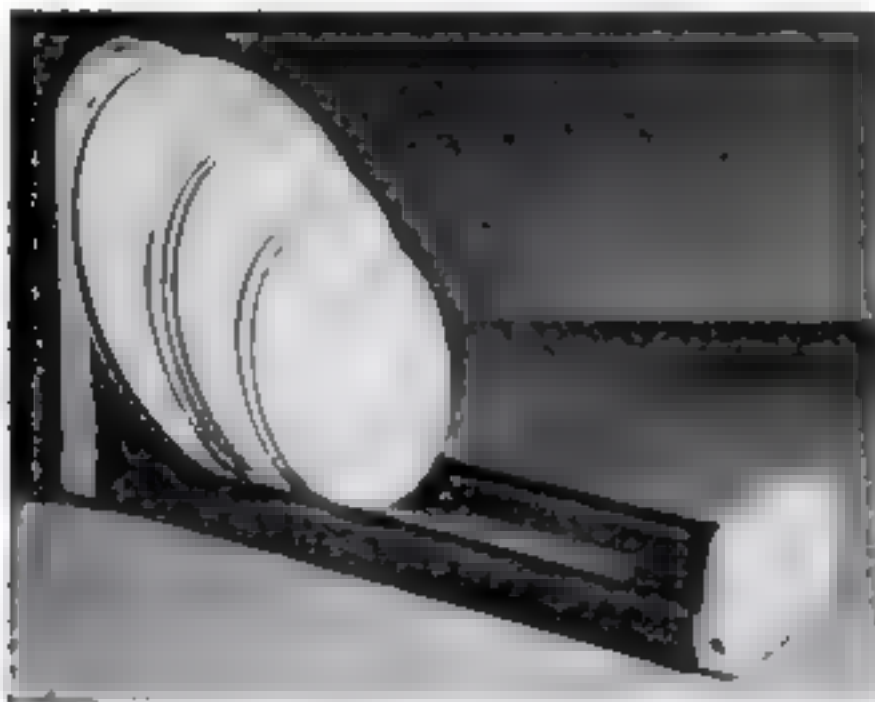
A FIBER "CHART," ruled and numbered for symmetry, dries lace doilies without the need of ironing. It is shown by Lewis & Conger, of New York.

COPYHOLDERS for typists, now made of hardwood by the Rite-Line Sales, Co., Inc., of New York, can be adjusted for single, double, or triple spacing.



DISHES DRAIN in less space when put on the rack shown below. Said to have been designed by a butler, the piece is wood and has rubber guards. It holds up to 30 dishes, leaving air space between them.

BED PILLOWS WON'T SLIDE off the end of a couch when supported by a removable headboard (another Lewis & Conger article) that is anchored by a horizontal piece held between the springs and mattress.





Courtesy The Linde Air Products Company

Cutting with the Oxy-Acetylene Flame

THOUGH so many uses for the oxy-acetylene torch have been developed in industry that mechanical control is now widespread, the hand-cutting blowpipe is still important for many special jobs. These are found in shipyards, forge shops, steel foundries and steel mills, structural steel work, and scrap yards, where the speed and economy with which metal can be cut make oxy-acetylene tools indispensable.

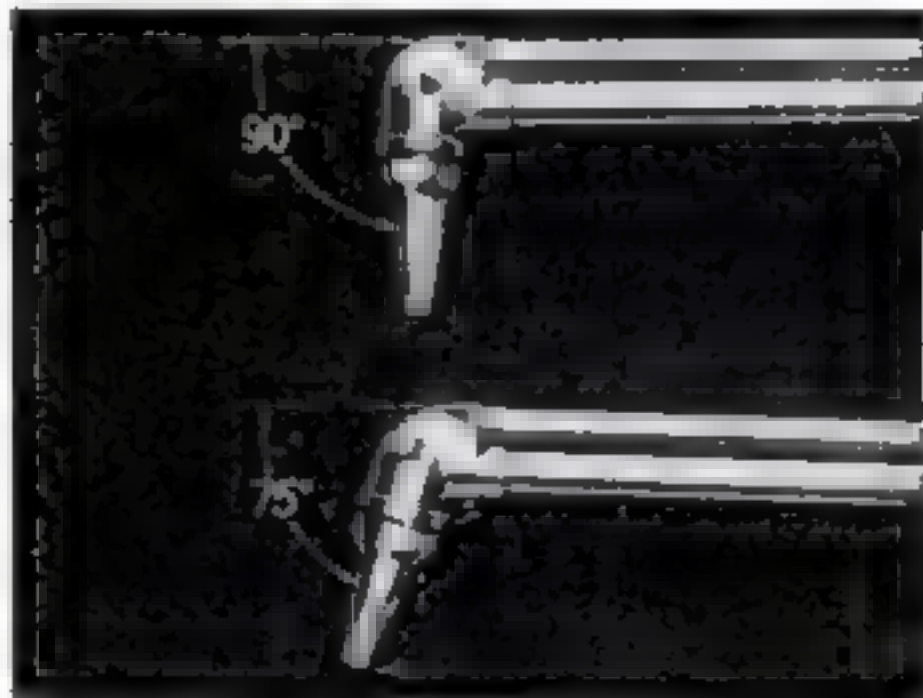
Whether mechanically controlled through

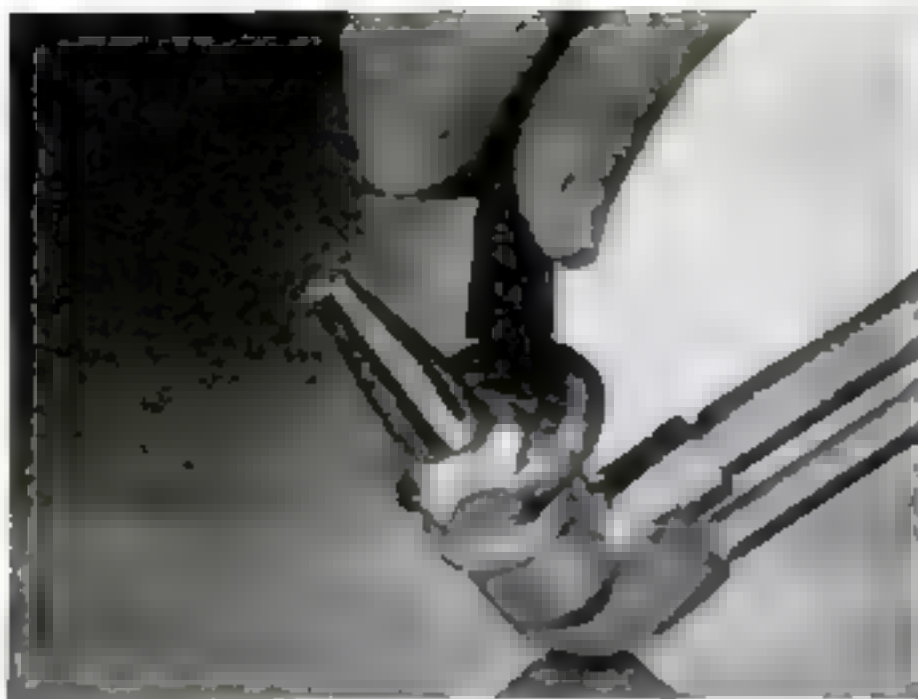
one or a series of units, or operated by hand, oxy-acetylene cutting follows the same principles. These principles are illustrated step by step below and on the following pages in a series of photos prepared by The Linde Air Products Company, of New York.

In practicing cutting with the oxy-acetylene flame, select first a piece of scrap steel plate $\frac{1}{2}$ " thick and about 4" wide. Clean the surface with a wire brush; then proceed in the following manner.

1 Mark off the line to be cut with soapstone and a straightedge; then make a punch mark with a center punch every $\frac{1}{8}$ " to keep your line of cut visible when the heat obliterates the soapstone

2 Hand-cutting blowpipes come with 90-deg. or 75-deg. heads. Either is satisfactory for a straight-line job, but operators' preferences may differ. A 90-deg. head is used in these photos





3 Select the size nozzle your blowpipe maker recommends for cutting $\frac{1}{2}$ " steel, insert it, and with the proper wrench draw up the nut just tightly enough to make a gas-tight connection



4 Hold the blowpipe in your right hand, if you are right-handed, in the manner shown above. Without lighting the gas, practice operating the lever that releases oxygen for the cutting action



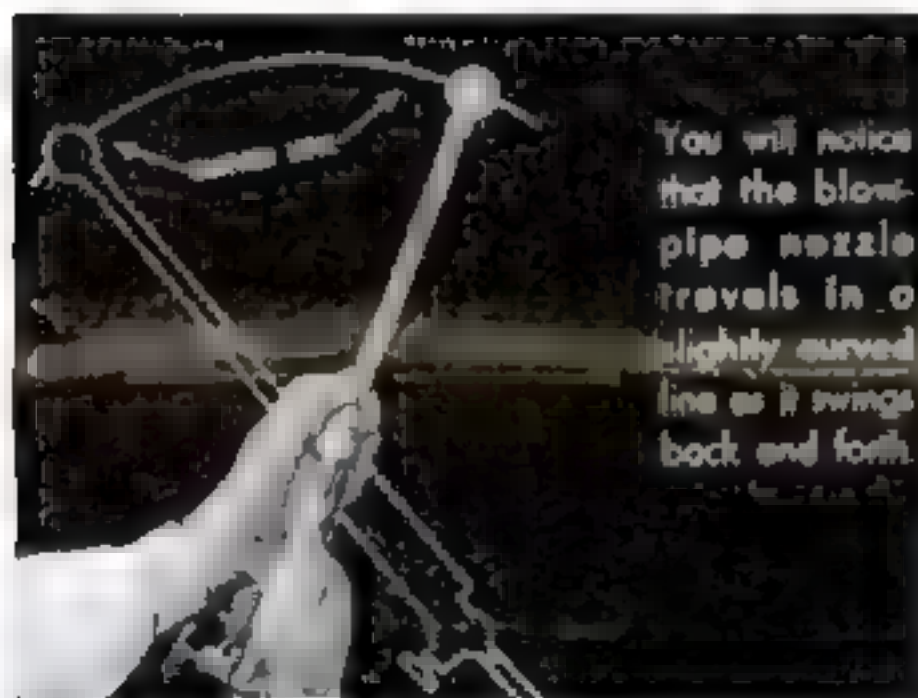
5 Then support the other hand on a block about 10" from the line of cut. This is the hand that will balance the torch. A thicker block or a firebrick is better if a 75-deg. head is used



6 Begin by holding the nozzle over the middle point of the line of cut. Using your left hand as a pivot and your right as a guide, swing the tip from one side of the plate to the other

7 To make a straight-line cut, this curve must be eliminated. Simply roll the supporting hand (the left) to increase the distance between the tip and pivot. This action requires practice

8 Start a cut by rolling your left hand forward and toward your right side. These movements will carry the nozzle to the end of the straight line where cutting is to begin. (Turn the page)



You will notice that the blowpipe nozzle travels in a slightly curved line as it swings back and forth.

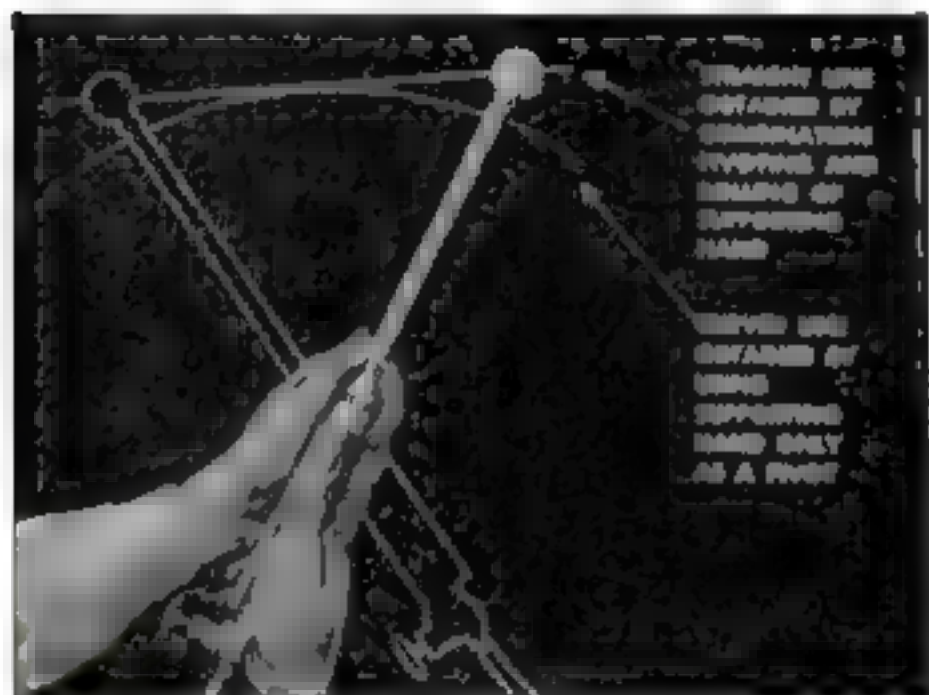




9 At the middle of the cut, your left hand will be in normal position with the nozzle at the middle of the straight line—the point at which the straight line and the theoretical curve touch

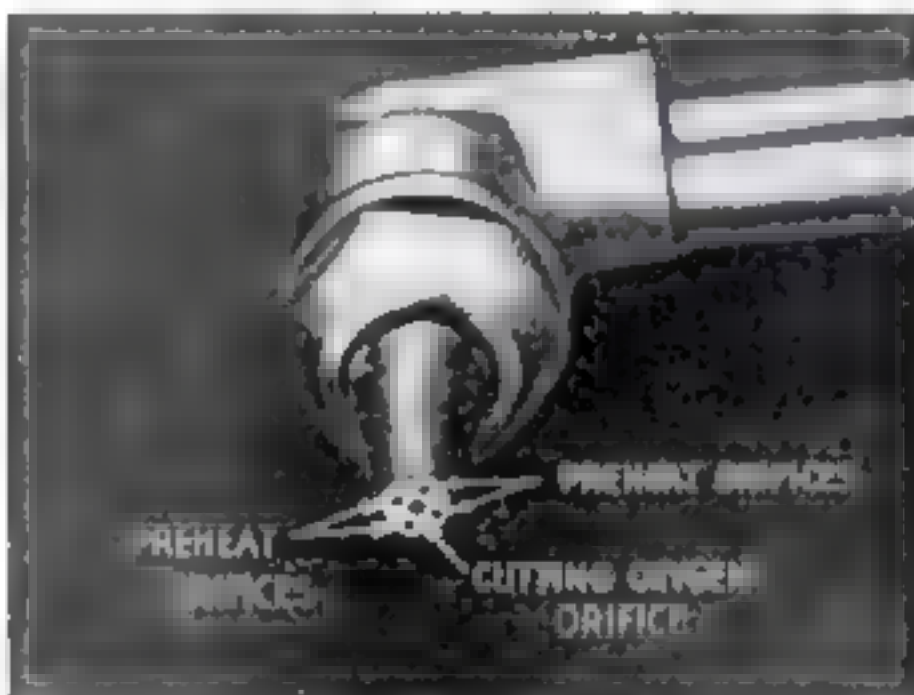


10 For the latter half of the cut, again roll your left hand forward, but this time toward your left side. This combined movement takes the nozzle above the curve and to the finishing point



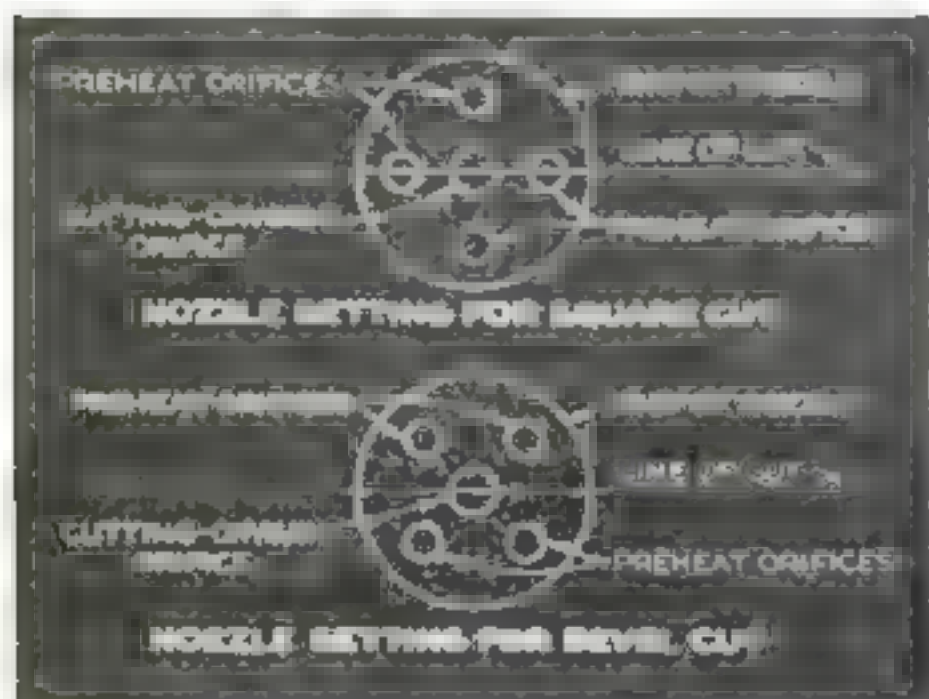
11 Rolling the hand that supports the blowpipe eliminates the tendency to describe a curve. Practice until you can move the nozzle steadily along the line; then practice with gloved hands

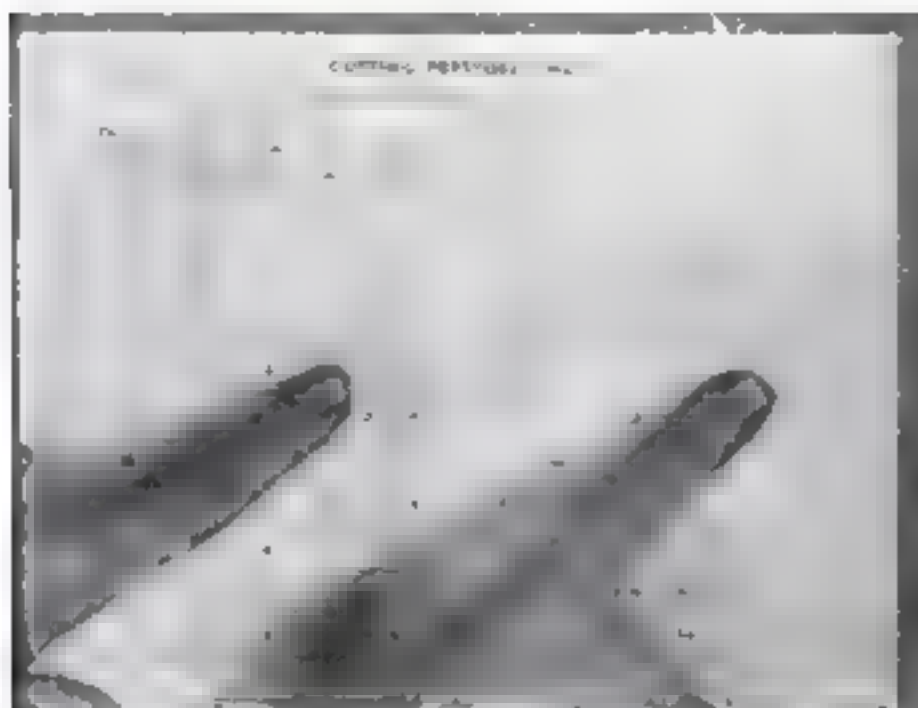
13 In making square cuts, set the nozzle so two jets strike the line of cut directly—one in front of and the other behind the cutting oxygen. All are equidistant from the line for bevel cuts



12 There are four preheating orifices in the nozzle. When set properly by the operator, they bear correct relation to the line of cut and most efficiently distribute heat for preheating

14 These are the four positions of the nozzle for preheating and cutting. The cut starts at the operator's right. These views are from in front of the torch, not as the operator sees it





15 Before lighting the blowpipe, consult your chart. Here we see that for $\frac{1}{2}$ " thick plate and a 25' hose, oxygen pressure should be 30 to 35 lb. per sq. in. and acetylene pressure 4 lb.



16 Next, roll down your sleeves and trouser cuffs to keep them from catching sparks, and put on your gloves and goggles. Then light the torch and adjust the preheating flames to neutral



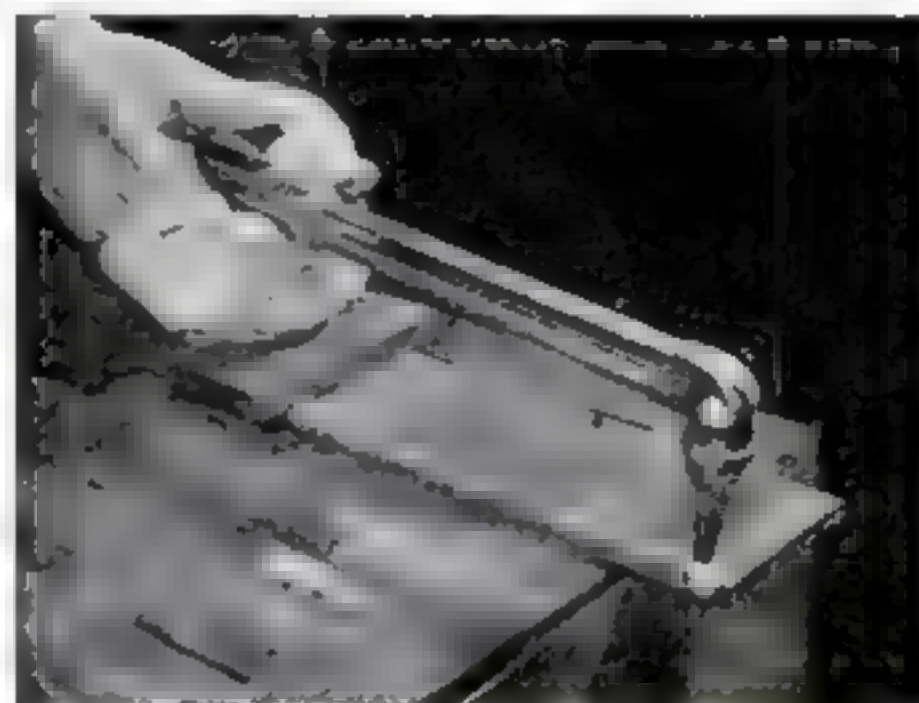
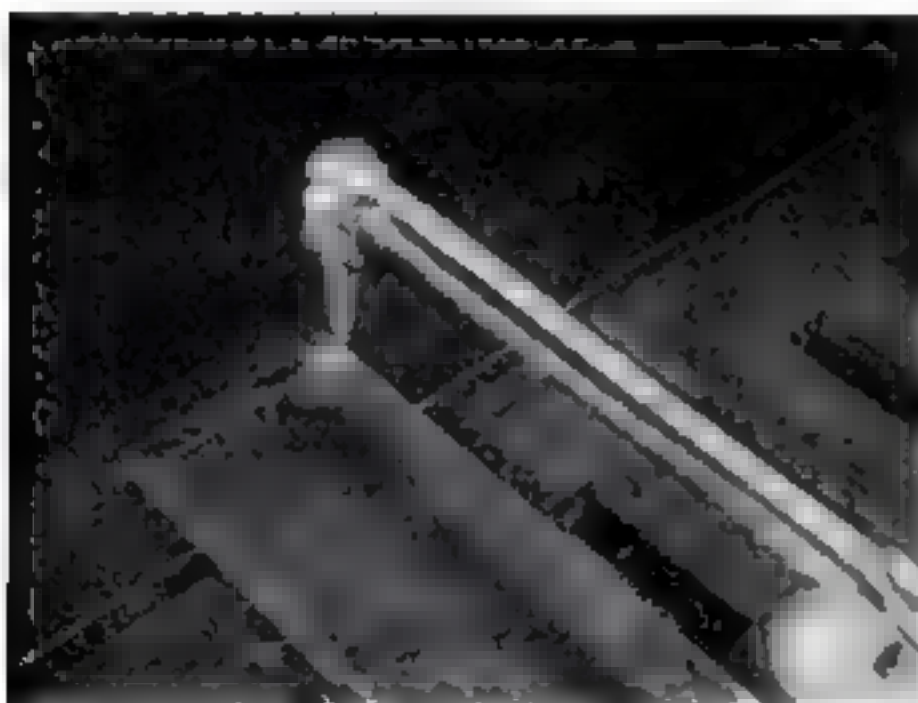
17 Preheat, holding the nozzle perpendicular and the central cutting-oxygen orifice directly over the edge of the plate at the punched line. This preheats both the top and side of the plate



18 Do not let the tips of the inner cones of the preheating jets quite touch the metal. If these tips are about $\frac{1}{16}$ " away, better heat distribution and better final cutting will result

19 Avoid attempting to rush the start of the cutting action. Hold the nozzle steady and keep it perpendicular to the surface until the spot under the preheating jets becomes white hot

20 Then tilt the nozzle slightly to point the flame outward from the plate and toward your right, and open the cutting-oxygen valve slowly by pressing down on the lever. (Turn the page)





21 Showering sparks will indicate the start of cutting. When this occurs, straighten the nozzle to the perpendicular again, press down all the way on the cutting lever, and latch it down



22 Finally, when the cutting action has fully penetrated the plate, tilt the nozzle so the flame points slightly in the direction of cutting; then move the torch slowly along the line of cut



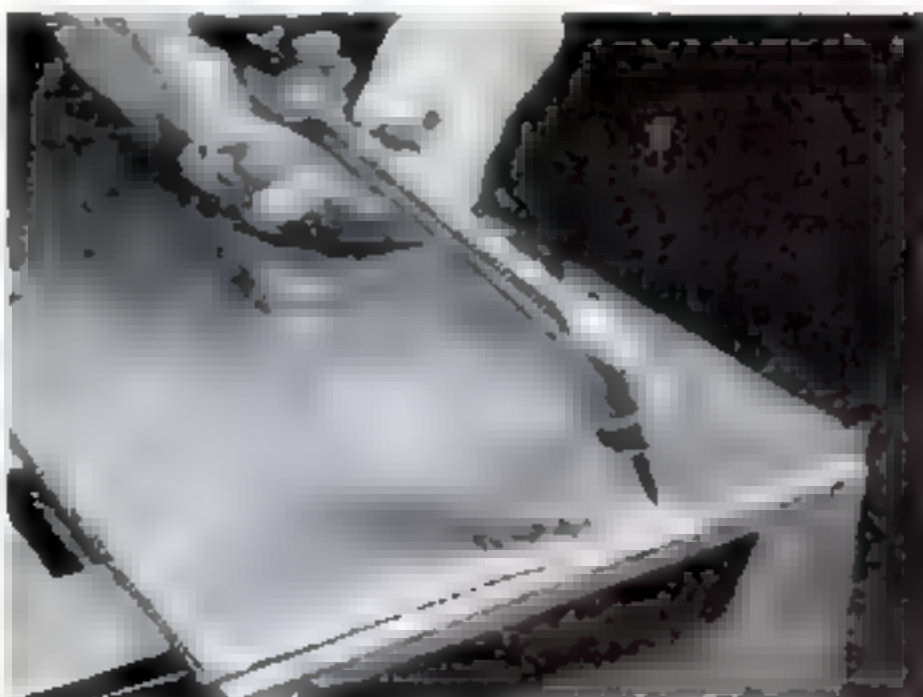
23 Should the torch be moved forward too fast, the cutting action will stop. The cut is then said to be "lost." When this occurs, you must release the oxygen lever and restart the cut



24 Restart a lost cut in the scrap part of the plate near the point where the cut stopped going clear through. Tilt the nozzle toward the cut section to prevent an upward shower of sparks

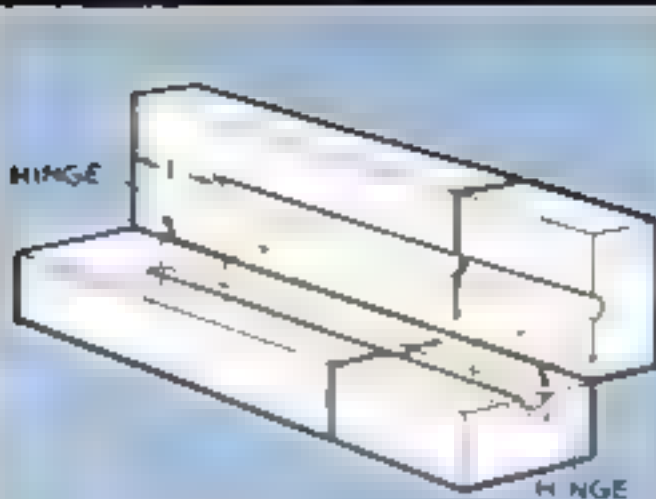
25 To move the nozzle toward or away from you, simply slide the blowpipe through the hand supporting it. Practice changing the direction of the cut without stopping the cutting action

26 When hand-cutting straight lines longer than about 4", start at the right-hand edge; then after cutting as far as convenient, shut off the oxygen, move the block over, and restart the cut

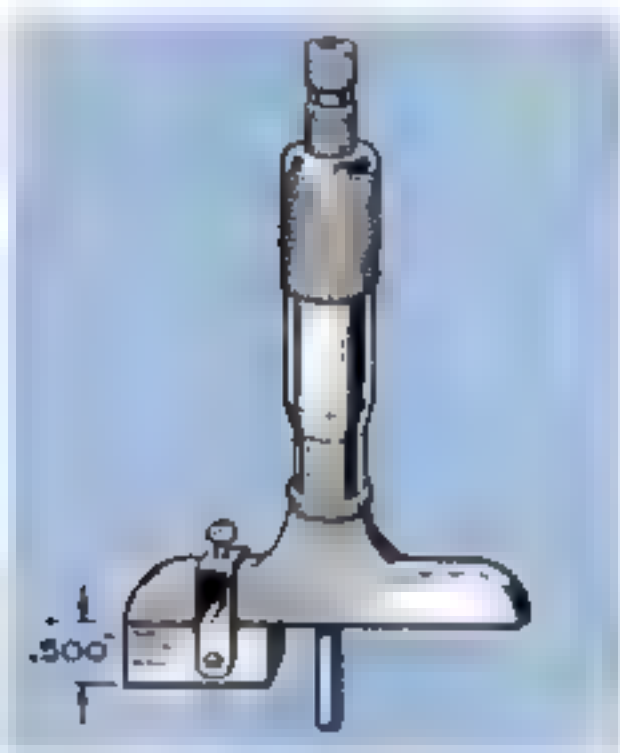


NEW SHOP IDEAS

AIDED BY THIS JIG, I recently made 100 nipples, $1\frac{1}{2}$ " long, from $\frac{5}{8}$ " thin-wall pipe. To make the jig, I first bored a $\frac{5}{8}$ " hole in one end of a $1\frac{1}{2}$ " by $1\frac{1}{2}$ " by 8" block of wood, extending the hole to within 1" of the opposite end. Then I sawed the block in two through the center of the bored hole. Next, I measured $1\frac{1}{2}$ " up from the bottom of the hole and cut a slot at that point to take a hacksaw blade. Finally, I fastened



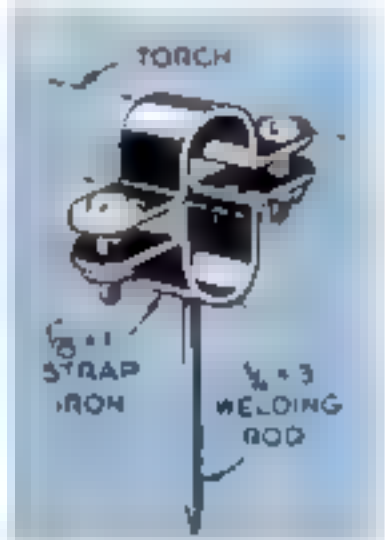
the pieces together with two small hinges so the jig could be opened to take out the cut lengths. By varying the dimensions, jigs may be made to cut any number of duplicate pieces of pipe or rod to a desired length.—O. C. SPRINKLE.



WITH THIS ATTACHMENT, a depth gauge may be used as a micrometer height gauge or to center a milling cutter. The device consists of a machine-finished block and a clamp. The block is .500" high and of a length and width to suit the dimensions of the gauge. Drill a hole through it to take a $\frac{1}{8}$ " pin. Make the clamp from $1/16$ " stock, drilling and tapping the middle to take a small machine screw, which is used for tightening the block against the gauge. Attach the clamp to the block by inserting the $\frac{1}{8}$ " pin and peening its ends.

To center a milling cutter, place the gauge alternately on each side of the cutter, take readings against the work, and move the work until the readings on both sides are the same.—JAMES J. MCDOWELL.

CIRCLES MAY BE CUT with an oxy-acetylene torch if you add the centering attachment shown below. It consists of a 3" length of $\frac{1}{4}$ " welding rod, two pieces of $\frac{1}{4}$ " by 1" strap iron, and two $\frac{1}{4}$ "-20 roundhead machine screws and nuts. Bend the two pieces of strap iron to fit snugly around the torch, leaving lips on each end. Drill these flanges for the machine screws. Weld the rod to the center of one of the pieces; then grind the free end of the rod to a point. Fasten the clamp to the torch with the screws and nuts, set the radius by sliding it along the torch, and tighten. Centerpunch the stock to be cut and place the tip of the rod in this mark.—PAUL CAMYRE.



TO MAKE A CUTTING OIL for use on metals that are especially difficult to work, dissolve in some hot water all the trisodium phosphate it will take. To every eight parts of this solution add one part of lard oil.—P. A. STAFFORD, JR.

METAL PIECES will not be marred by the jaws of a vise or a chuck if you wrap scrap pieces of photographic film around them before clamping down. The film, in either the developed or the undeveloped state, provides a good grip, is uniform in thickness, and is not softened by oil.—W.E.B.





WOMEN WELDERS

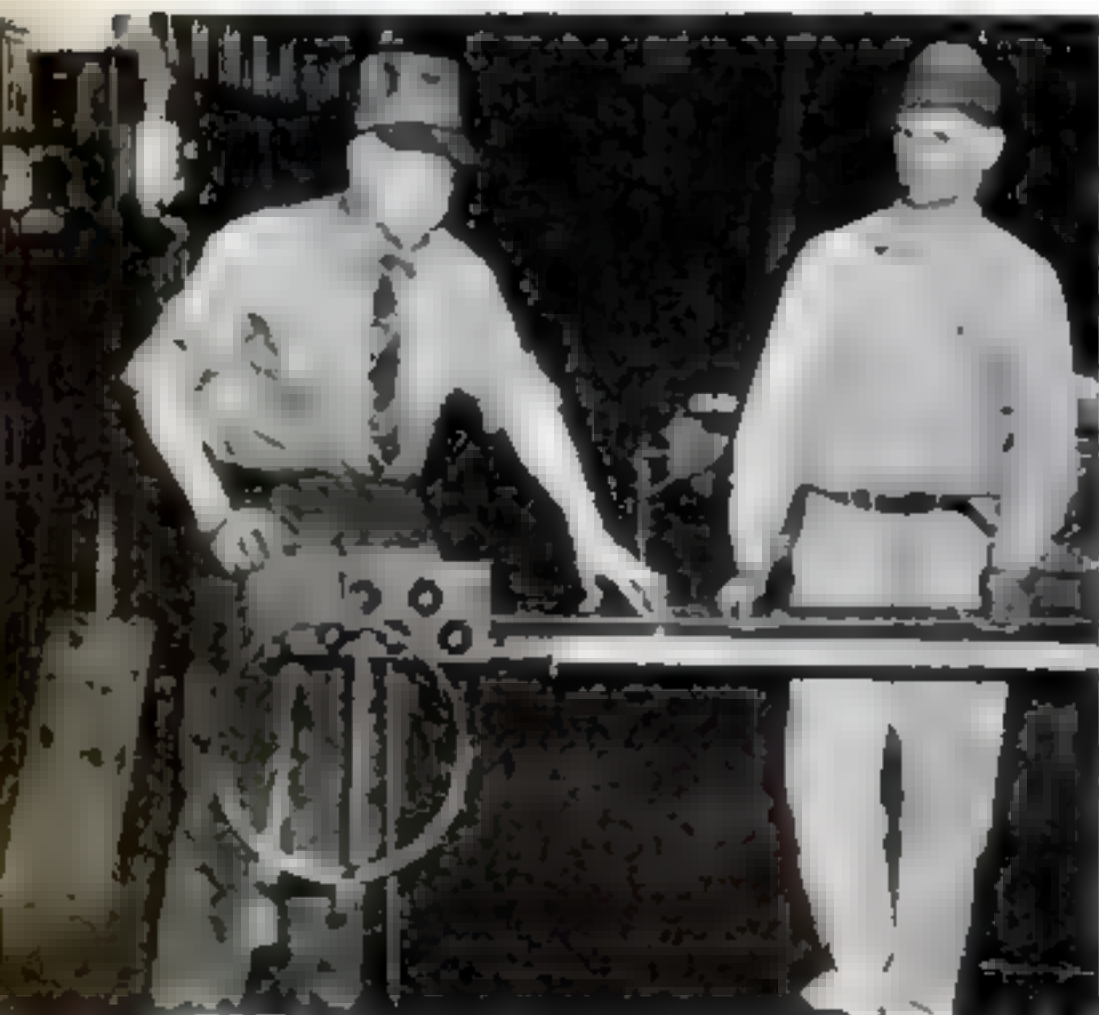
in Uncle Sam's ship-yards are being out-fitted with coveralls of split cowhide like those at right. The suit is treated to resist flames.

SCRAP-IRON ROD

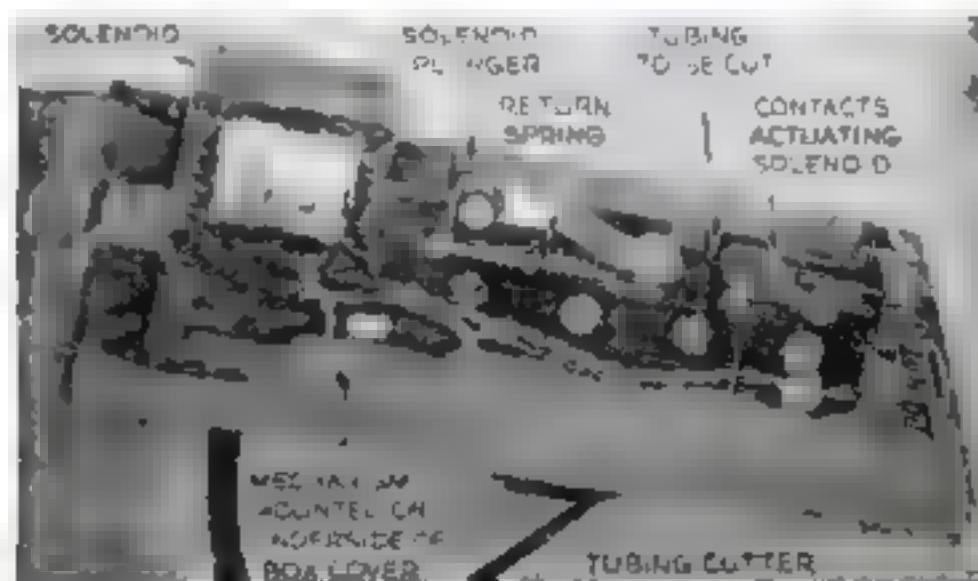
cut into short lengths and inserted behind the shower heads at Fort Sill, Okla., reduced the flow of water from $7\frac{1}{2}$ gal. per minute to $5\frac{1}{2}$ gal. — saving 400,000 gal. daily and cutting annual pumping costs by \$7,000. The idea was that of Harry L. Arnold, shown at left, civilian plumbing superintendent at the post.



ROLLED STEEL TUBING is straightened quickly and efficiently by the simple device shown below. It was invented by Howard Knisely (left in the photo) and Frank Babcock (right), employees at the Grove City, Pa., plant of The Cooper-Bessemer Corp. A coil of the tubing is put in position over a bracket at the side of the straightener, and one end is threaded through a series of five rollers, as shown. Straightening is done by pulling the tubing along the tray, where it is measured and cut off to required length as needed. Until this method was introduced, straightening operations at the plant were done entirely by hand.



AUTOMATIC CUTTING of insulation and cable-identification tubing into short lengths is done with a solenoid plunger at Northrop Aircraft, Inc., Hawthorne, Calif. Tubing is fed into a plywood box, as shown above at the right, and actuates the solenoid by forcing a spring-steel stop against a contact on the underside of the lid (shown open below). The plunger sends a blade through the tubing, and a spring returns it. Length is controlled by the distance between cutter blade and contact. The device was perfected by Sam D. Carter, of the company's electrical department.





Modelmaker's Surface Gauge

By C. W. WOODSON

IN MODELMAKING and other delicate jobs, a surface gauge made as shown here will scribe lines at a given height from the base of the work, locate centers, transfer dimensions to duplicate parts, and perform other tasks of this nature. It is not limited to vertical work, for the bent end of the scribe can be used for marking horizontal surfaces or as a height gauge when measurements of extreme accuracy are not required.

A steel-block base is slotted for an adjustable bracket that holds a rotating scribe

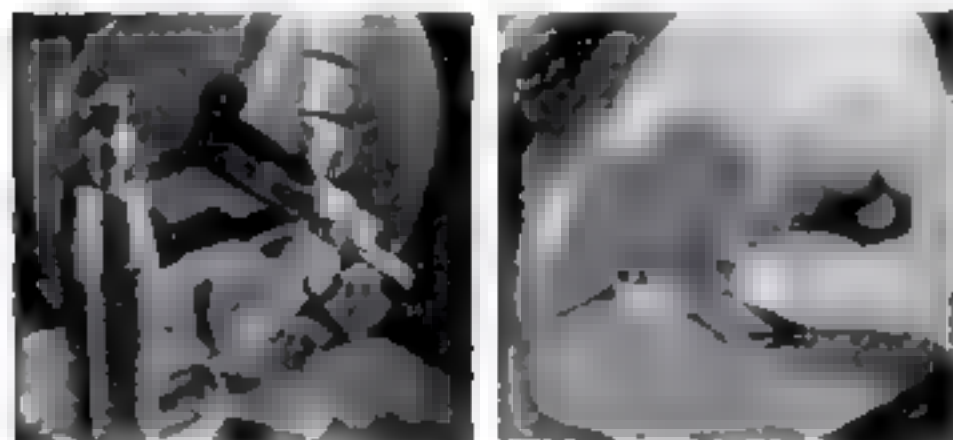
head. The bracket is pivoted on two fillister-head screws against the pressure of a stiff spring in a $\frac{1}{4}$ " diameter hole at the base of the slot. Adjustment is made with a knurled thumbscrew.

The rotating head is designed to hold the scribe in any position with the aid of a spring until it can be locked by a clamp nut. Two gauge pins, held in the base by friction, push down for use as a guide against the edge of a surface plate or against the edge of the work.

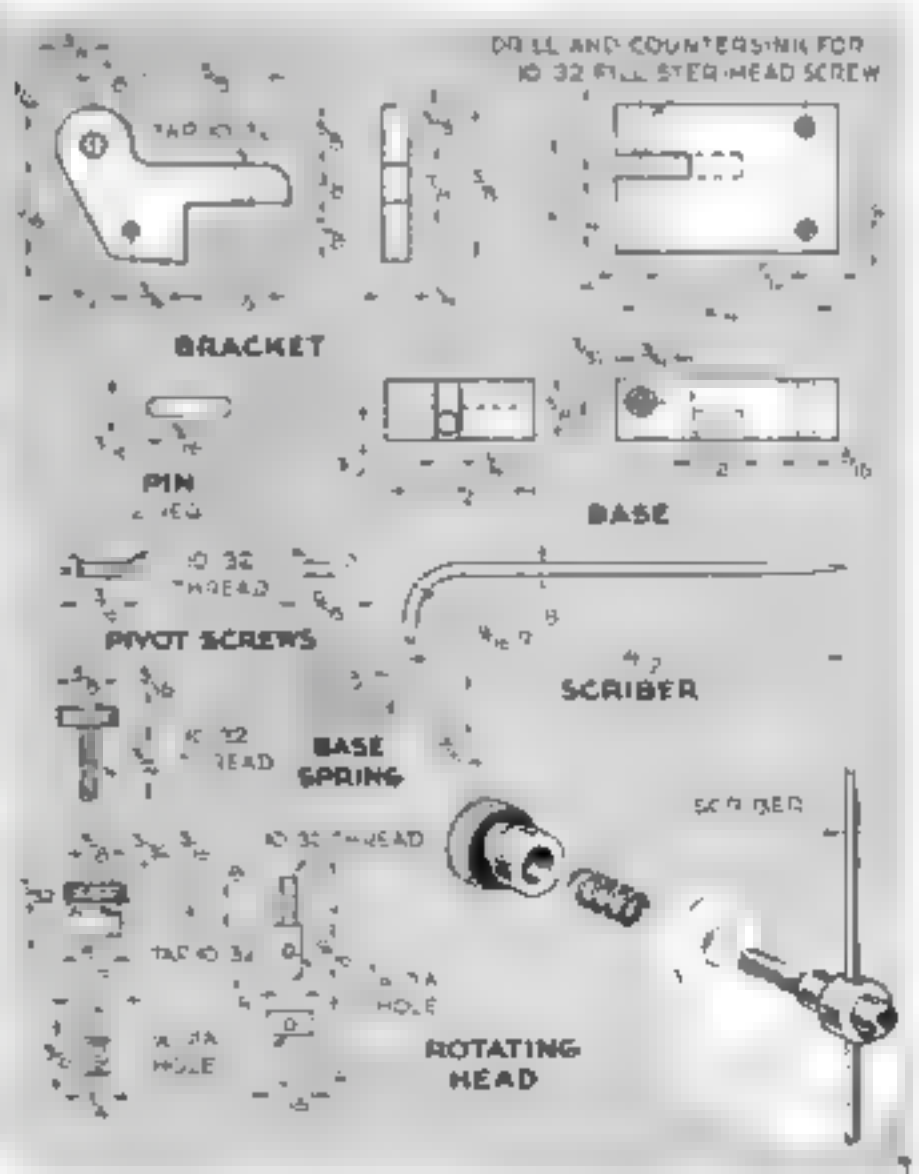
Cut the base and bracket from cold-rolled steel, drill as shown, and polish on a disk sander. Turn the thumbscrew and clamp nut from steel rod and knurl the heads. Thread the thumbscrew with a die, and tap and counter-bore the nut for its spring. Parts

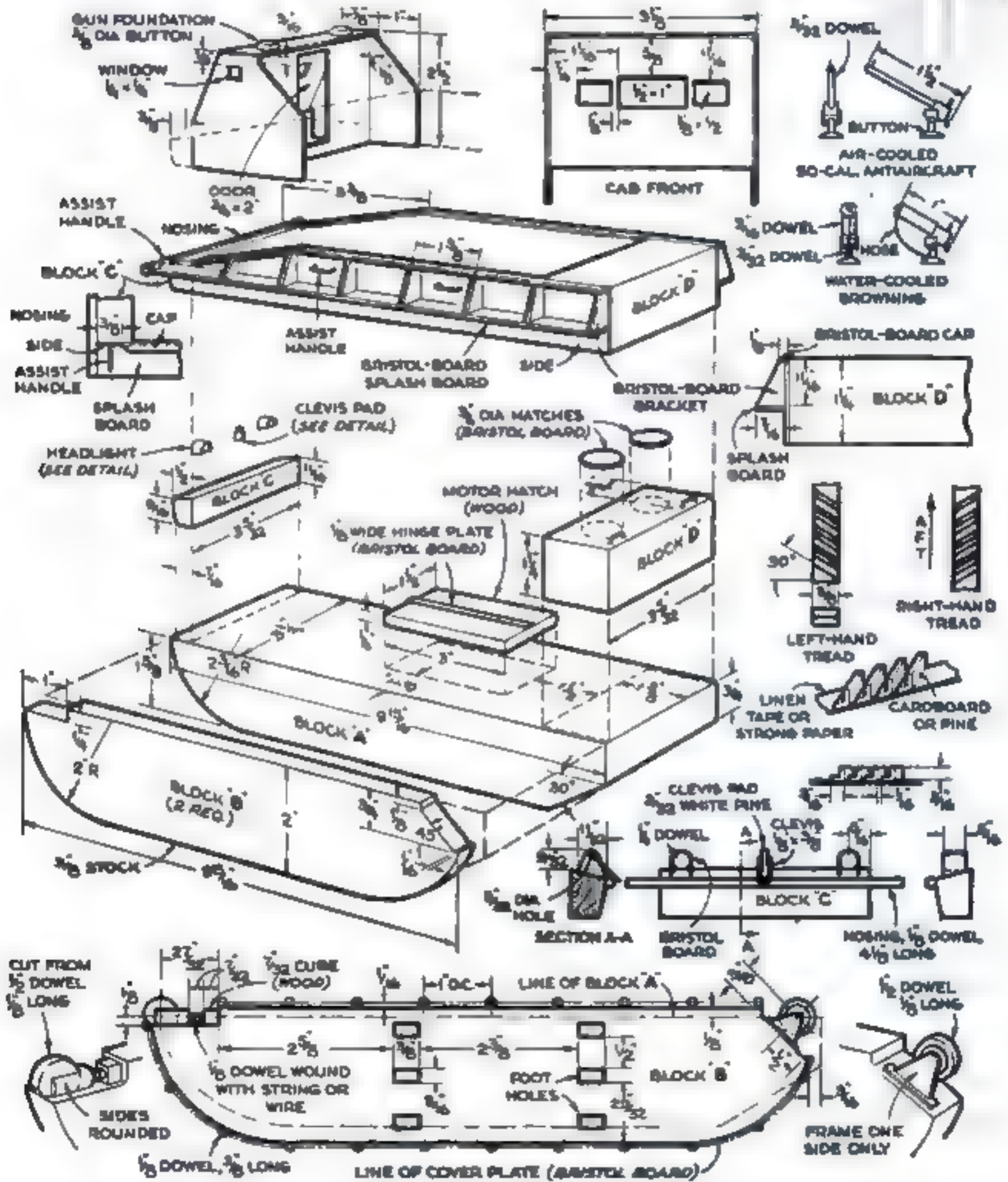
for the rotating head are turned and drilled, the pivot screws turned to shape on the ends, and the springs ground to length. Drill rod is pointed for the scribe, bent to shape, and hardened and drawn.

Dimensions in the drawing may be changed slightly, if desired, to meet particular needs, but this should be done with care to avoid trouble in the final assembly. The length of the scribe is possibly the least critical. If springs of the sizes indicated are not available, the holes in the base and clamp nut should be altered to suit.



Two operations in making parts for the little gauge are illustrated above, while all finished parts are shown below. The dimensions are given in the drawing





AMPHIBIOUS ALLIGATOR TANK

Build This Realistic Model of the Leathernecks' Landing Craft

USED with marked success in the Pacific area, the famous Marine Corps amphibious Alligator tank is the prototype of this model. The original measures 8' wide by 20' long, while the model, scaled down to $\frac{1}{8}$ " to the foot, is 4" by 10".

Make blocks A, B, C, and D from white pine. Note that two B blocks are required and that C is shaped to continue the curve of the forward end of A. Cut the sides, cab, splash boards, caps, and brackets from Bristol board and glue them, as indicated, to C and D; then glue this assembly to A.

The pair of machine guns on the cab may be either the .50-cal. air-cooled antiaircraft guns shown in the photos or water-cooled Brownings—both are detailed in the drawings. Make the headlights from short lengths of $\frac{1}{4}$ " doweling and add hoods fashioned from stiff paper.

Use paper-clip wire for the clevis and the assist handles. Cut the clevis pad from white pine. The nosing, made from $\frac{1}{8}$ " doweling, is $4\frac{1}{2}$ " long. Mount two circular Bristol-board access hatches on the after-deck and a rectangular motor hatch, of wood and Bristol board, in the cockpit.

Glue $\frac{3}{8}$ " lengths of $\frac{1}{8}$ " doweling—for rollers—at 1" intervals along the top and the rounded bottom of B. Make the drive and idler wheels from $\frac{1}{2}$ " doweling. Support each idler wheel by Bristol-board frames, as indicated. Make the simulated tension springs from heavy string or fine wire, winding each piece several times around a $7/32$ " length of $\frac{1}{8}$ " doweling and gluing it in place.

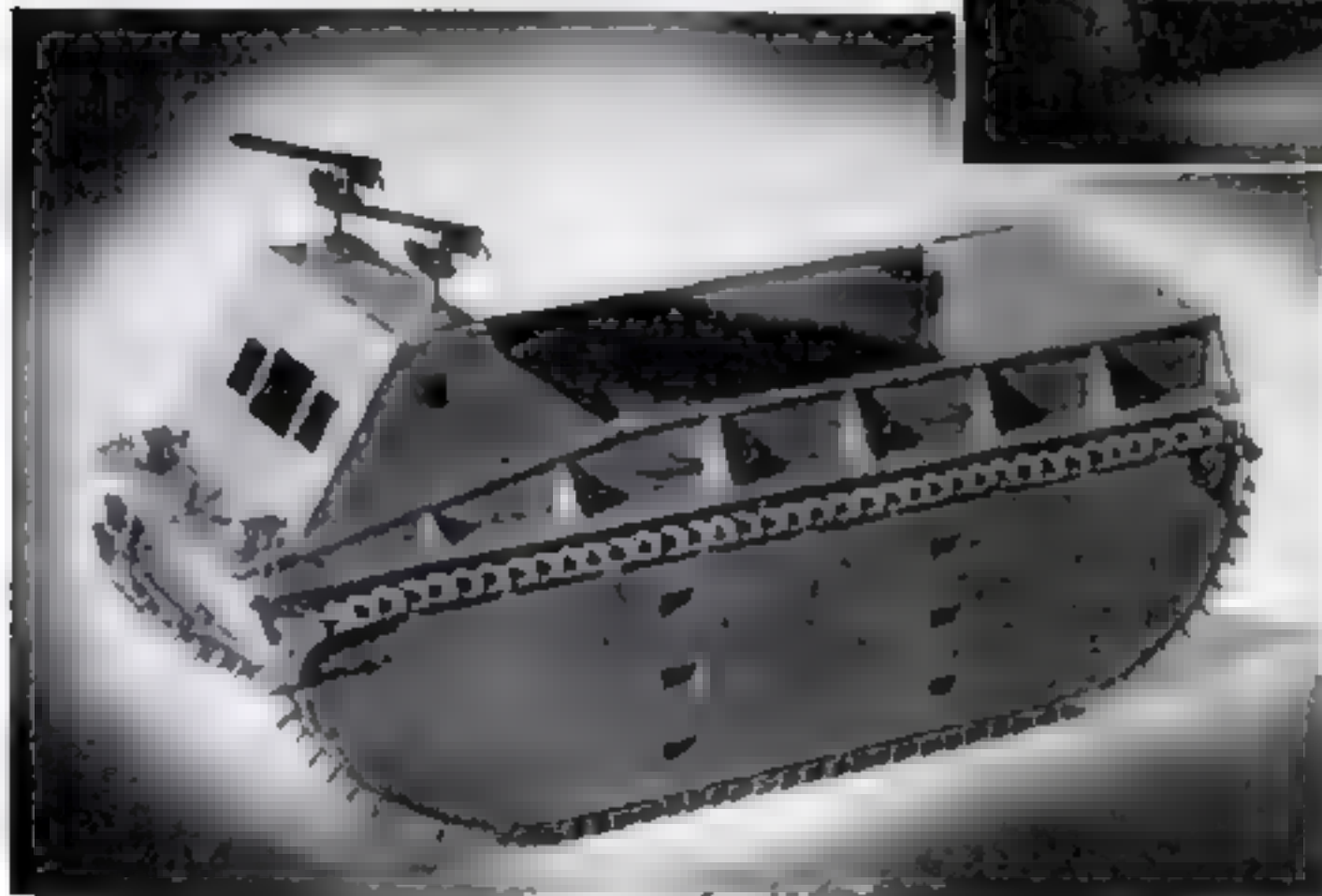
The treads are made from white pine or cardboard and mounted on a linen-tape or strong-paper track. Cut them at an angle of 30 deg. When you have enough for one track, reverse the direction of the cut, since the two tread assemblies toe in toward each other. Glue the treads to the tracks at the proper angle; then glue the tracks to the rollers and to the drive and idler wheels.

Cover plates are made from Bristol board. Cut each so it overlaps block B by $1/16$ " all around except in the way of the drive and idler wheels. Glue one to each block; then cut footholes through it and the block. Finally, glue the tread assemblies to A.

Paint the front of the headlights silver or white. Finish the rest of the model with two coats of flat medium-gray paint. Identifying symbols and numbers, if desired, should be black.—JOHN J. GALLIVAN.



The pigeon-toed treads, shown above, throw water outboard and back of the hull, thereby diverting spray from the personnel



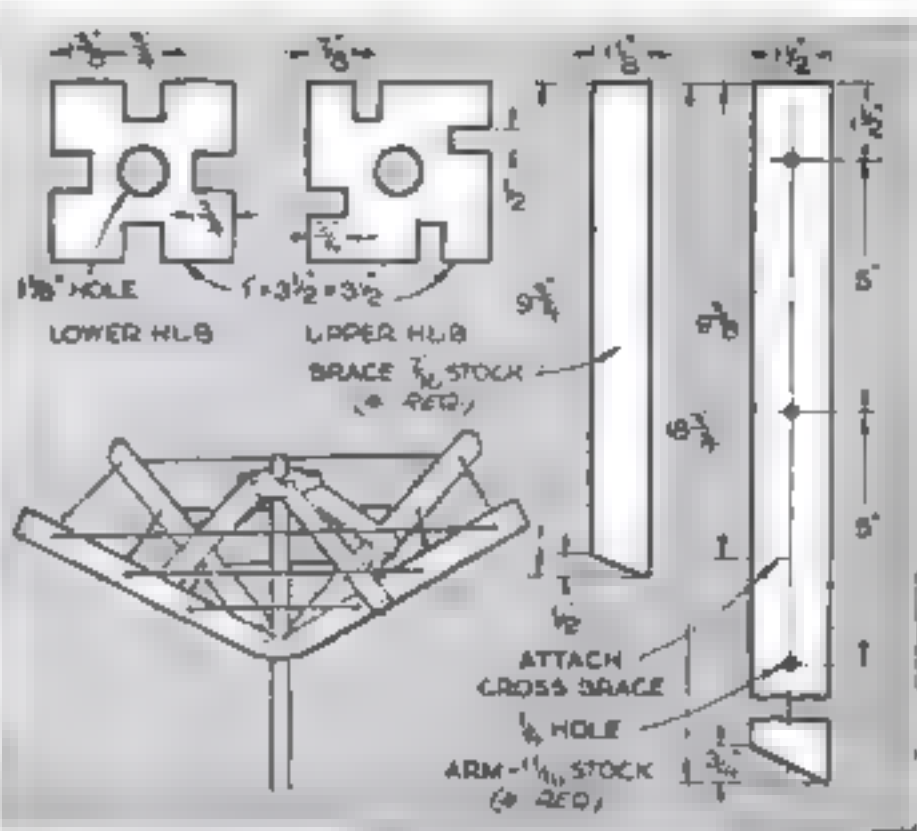
On top of the cab are a pair of machine guns that are effective weapons for either attack or defense. A towline may be attached to the clevis on the bow

Whirligig Clothes Reel Is Practical Washday Toy for Girl



WITH a miniature whirligig clothes reel modeled after her mother's, a little girl can have fun doing her doll's or her own clothes on washtday. The one shown stands about 36" high.

Make hubs for the revolving frame from blocks, bored with center holes large enough to turn on the pole, which can be a standard 1" diameter broom handle. Notch the lower hub at the center of the sides and the upper off-center, as shown in the drawing. After boring $\frac{1}{4}$ " or larger holes in the arms to



take the clothesline, assemble the arms on the lower hub and the cross braces on the upper, using one 2½" nail for each of the former and 1¾" nails for the latter; then attach the braces to the arms with two finishing nails each. Drill all nail holes to keep from splitting the wood.

Drive a 20" length of lead pipe halfway into the ground as a permanent stand; then slip the frame on the pole, supporting the upper hub between 3" cotter pins $\frac{1}{4}$ " and 2" from the top.—BERRY POPKEN

Hacksaw Blade Forms Wrench for Turning Slotted Nuts



NUTS on bolts in saw handles and other pieces are often slotted to receive a special wrench. This tool can be improvised from an old backsaw blade by breaking across one of the holes and grinding to fit the slot. Hold it with pliers when force is needed in use.—W. E. B.

Threaded Nails Make Long Model Bolts



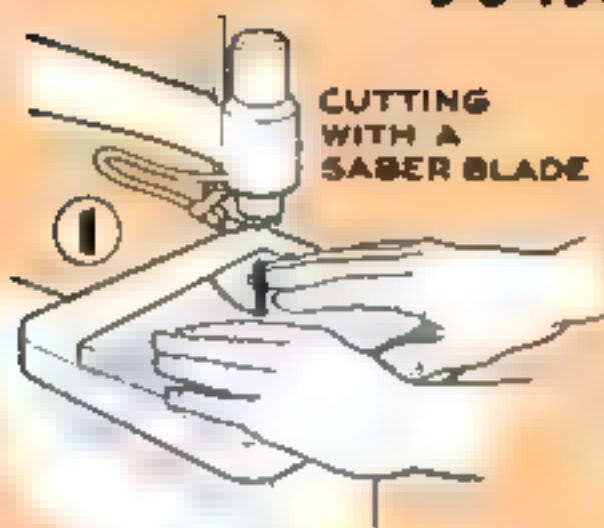
LONG, slender bolts of the kind required frequently in radio construction and model work can be made easily from large nails having a diameter that will take a 6-32 or 10-32 thread put on with a die. The heads can be left round and slotted with a thin file, or they can be filed square or hexagonal in shape.—RICHARD SALZER.

Manicure Emery Boards Useful for Variety of Small Jobs

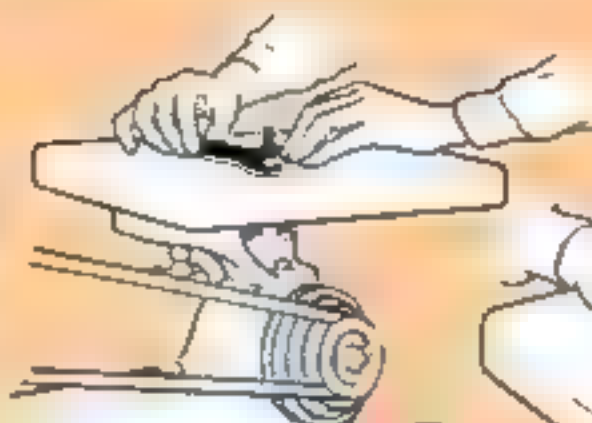
SMALL emery boards of the type used for manicuring are convenient sanding tools for the home workshop. With them, you can get at hard-to-reach places in modelmaking, fine cabinetwork, soldering, and the like. They come in 4½" and 7" lengths, have coarse grit on one side and fine on the other, and are durable.—CLIFFORD L. SCHWAB.



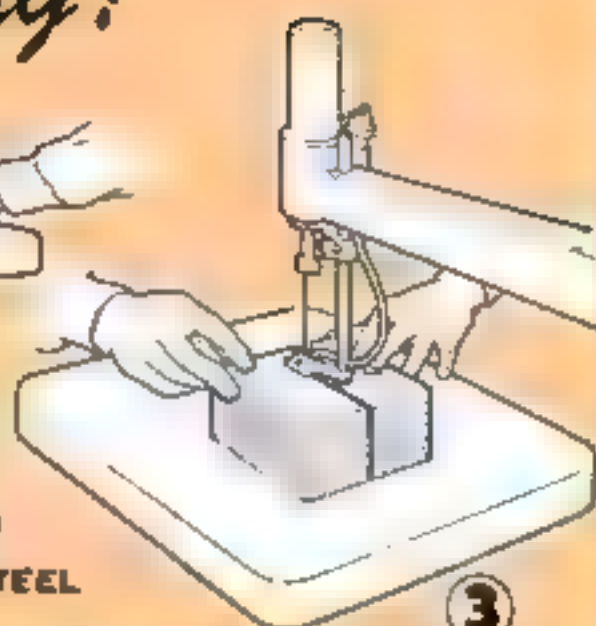
What's Wrong?



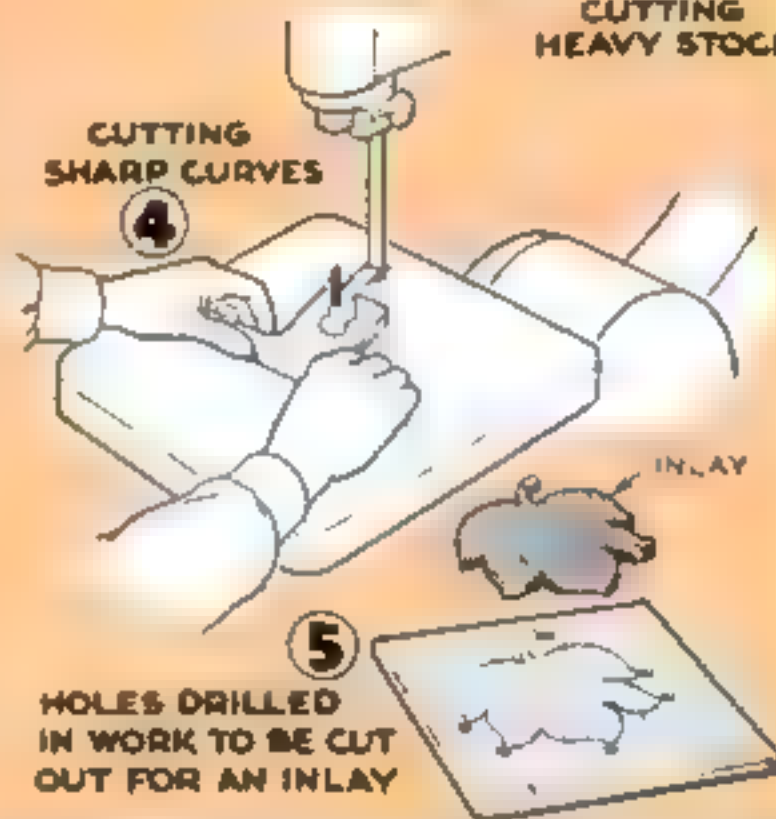
1
CUTTING
WITH A
SABER BLADE



2
FILING STEEL



3
CUTTING
HEAVY STOCK



4
CUTTING
SHARP CURVES

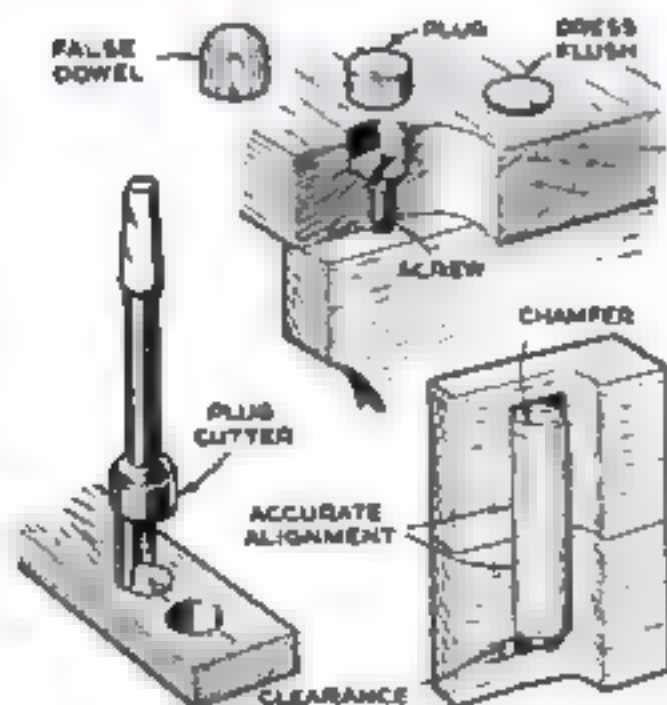
HERE are five ways in which the power scroll saw can be used. But in presenting them, the artist has made six errors which, if you followed his illustrations literally, would spoil your work. Try to spot two errors in one drawing and one each in the other four; then turn the page upside down to check with the correct answers.

1. Always have the teeth of the blade point down so they will draw the work against the table. Also the hold-down and roller guide should be adjusted to ride on top of the work.
2. Speed should be reduced.
3. The blade is too fine for the stock.
4. This blade is too wide to go around sharp curves without turning the stock and rough cutting.
5. Holes should be bored in waste wood so they won't show on the finished piece.

ANSWERS

USING DOWELS AND PLUGS

[WOODWORKING]

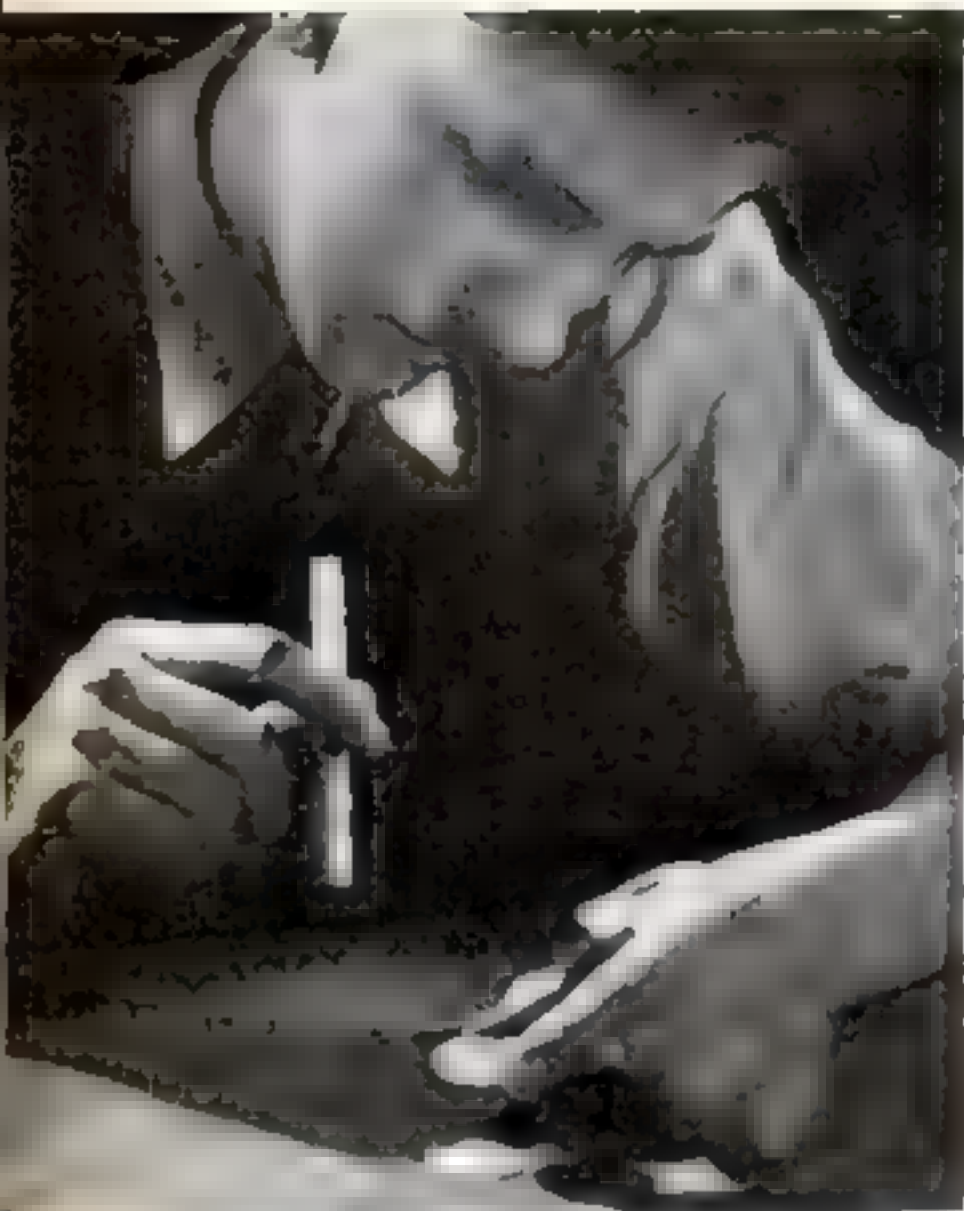


To insure strength in doweled joints, dowel pins must be properly used. This requires accurately fitting holes, well aligned and square with the joining surfaces, and end clearance to insure contact at the joint and to provide space for imprisoned glue. Chamfered ends help in assembly and prevent tearing the holes.

When hidden screws are employed, counter-bore for plugs and bore holes to fit the screw shank. Use the screwdriver cautiously to avoid bruising the edges of the holes. Cut the plugs across the grain from stock slightly thicker than the depth of the hole; then apply glue to them, align the grain with that of the work, and drive them in without tilting. Trim the plugs roughly with a chisel, and plane or sand them flush.

On Provincial-style furniture, to give the appearance of through dowels in the joints, use plugs rounded on the projecting ends. Lengths of dowel stock will be satisfactory.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



TO MAKE A DISK JUMP, hold a large coin about 1" above a slightly smaller paper disk, and blow strongly through a paper tube directly on top of the coin. The disk will rise to the coin, falling back when you stop blowing! Your friends will suck through the tube, and the disk won't move. Air blown past the coin produces lowered air pressure under it, and over the paper disk, however, and this forces the disk to rise.



BALANCE A NICKEL on edge and a paper match on it, and cover them with a clean, dry glass. Challenge friends to get the match off without jarring the table or moving the glass. When they give up, run a comb through your hair to charge it electrostatically. Hold it near. The match spins and falls off!

CATCHING AIR in a bag is amusing if you are dexterous and talk while you act. Tell your friends that air has weight and can be thrown like a ball. Pretend to throw a handful and to catch it in a paper sack. Have your friends toss handfuls into the bag. Each one appears to land inside with a thump—if you snap a finger against the bag!

IT'S EASY IF

THIS TRICK WITH CUPS is based on an illusion. Set up three cups before your friends, as shown below, and demonstrate that, turning over two at a time and always turning the middle cup, you can have them all bottom-side up in two moves. It's easy: all you do is turn the middle cup and one end cup, and then turn the middle cup back along with the other end cup. Now, with all cups upside down, turn the middle one upright and invite one of your friends to try his skill. He will find it impossible because the cups will be in the reverse position from which you started! It is surprising how few people will notice this.



YOU KNOW HOW

BLOWING A CORK INTO A BOTTLE isn't as easy as it sounds. Place one in the neck of a milk bottle or a similar wide-mouth bottle, and challenge your friends. To the surprise of anyone who blows hard, the cork will fly out into his face! The harder he blows, the faster the cork will fly out. This is because air is compressed in the bottle and forces the cork out. The trick is to blow gently with your mouth close to and directly behind the cork so the air will strike it instead of rushing past. It also may be worked by blowing through a straw held close to the front end of the cork.

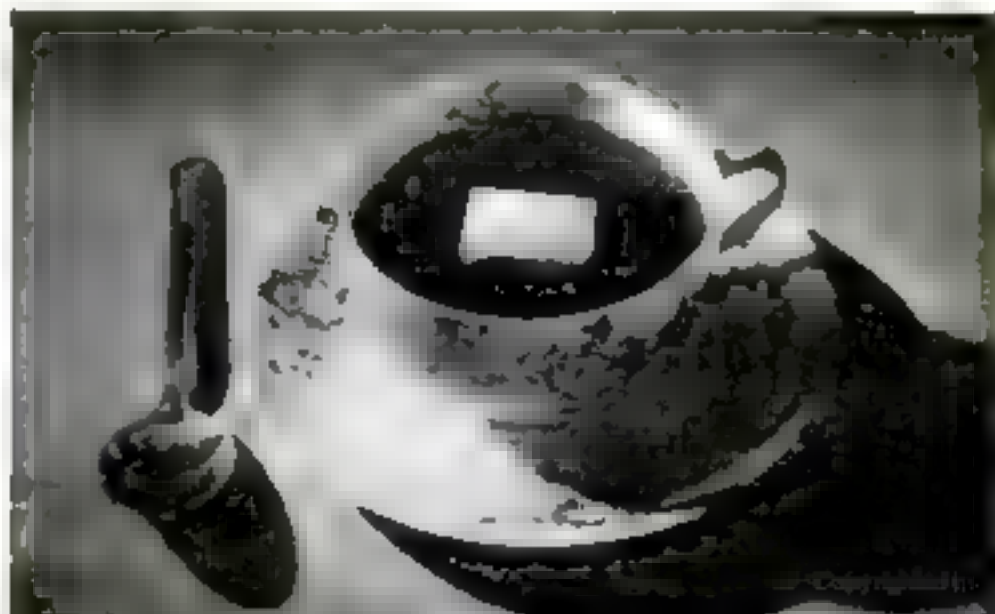


STRIKING A SAFETY MATCH on your shoe will startle friends who aren't in the know. Use any ordinary type of safety match, and pull the trick nonchalantly. Those watching will attempt to do likewise, and all will fail—for unseen on the instep of your shoe is an all-important material, rubbed in from the moistened striking surface taken from a book of matches! After drying, that area will light matches for weeks.



DIP YOUR HAND into a bowl of ordinary water, as shown above, and it will come out dry, if you know how! Before trying it, rub your hand with zinc stearate powder—the kind sold by drug stores as a dusting powder for babies and others. It won't be noticed, but it is water repellent if you take your hand out of the bowl quickly. Those not on to the trick will get wet every time.

SUGAR WILL FLOAT on the surface of your cup of coffee in a stunt that provokes amusement after dinner. After making sure the coffee isn't too deep in the cup, quietly stand one lump of sugar on end. Then call your friends' attention and balance a second lump on the first, as shown below. By watching closely, you can tell when the support is about to collapse, and can command the "floating" lump to sink.





Merlin's

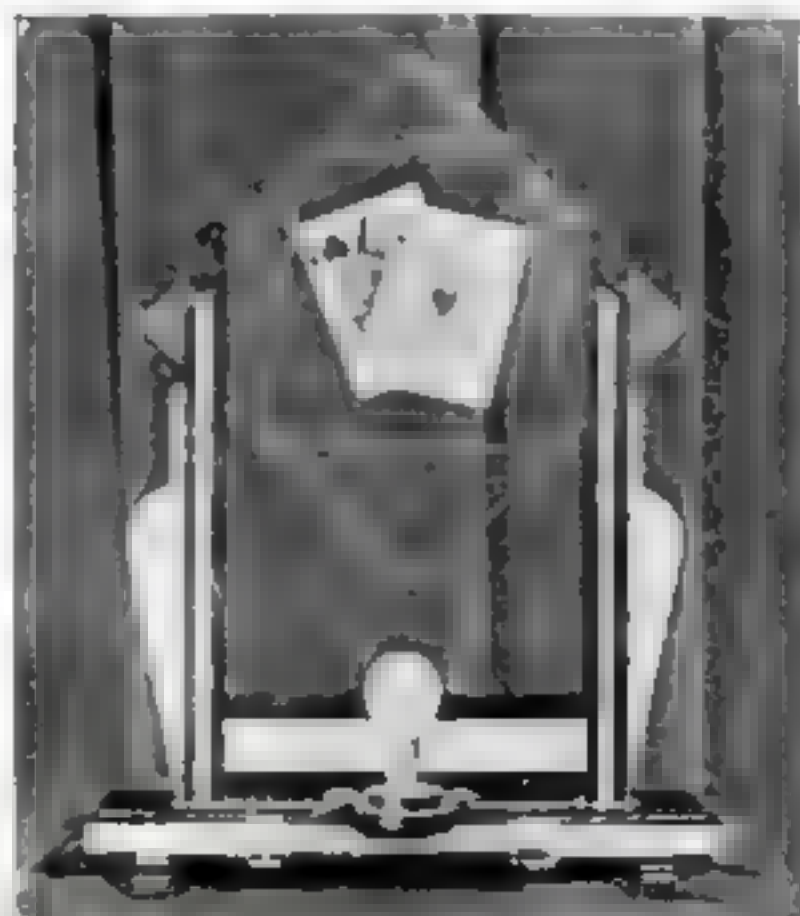


For a one-man shop, the equipment shown above makes a lavish array. Since this photo was taken, Snyder has constructed a complete dust-removal system, with a collecting hood over each machine. His printing presses, pictured at the left, are able to perform exacting color work

The trick shown below is the product of precise shop work. Two pieces of plate glass are held together with an elastic the flashbulb is fired, and instantly a pair of chosen cards appears in the glass

"A MAGICIANS' magician" is what one might justly call John Snyder, Jr., of Norwood, Ohio, for by the magic of his skill and ingenuity he produces tricks and effects with which his customers all over the world puzzle audiences of thousands. In a one-story shop that would be the envy of any home craftsman, Snyder works at what he insists is a hobby and is going to remain a hobby—the manufacture of equipment for professional and semiprofessional magicians. A strong individualist, he works alone in his shop by preference, often during both day and night

Here he designs new tricks, works out production methods, makes paints, assembles parts, sets up and prints instructions, and acts as a one-man



Workshop

CRAFTSMAN HAS ONE-MAN BUSINESS OF MANUFACTURING MAGIC

order and shipping department. In the evenings he generally handles his extensive correspondence, managing to reply to all letters within 36 hours.

For years Snyder was a professional stage magician, but in 1940 he decided to devote full time to his interest in creating magical illusions. For six months of each year he builds and sells equipment; during the remaining half year he divides his time between giving shows at military and naval hospitals and developing new tricks at his summer home in Fox Lake, Wis., where he also has a workshop.

His business policy is probably unique. Certain tricks have a strictly limited production; he will sell only one such trick in any one city, and will permit no one else in the same city to purchase a duplicate without the first buyer's permission. In the case of some special effects, Snyder makes only two or three copies, and even his less guarded tricks aren't made in large quantity. Nothing is sold from his shop during the months that he is away. A record is kept of every sale, no matter how small. The buyer's name, address, and other information are entered on a card that is kept with the stock, thus forming a self-renewing inventory.

The shop is air-conditioned and includes a dust-removal system that Snyder designed and built himself. Conduits made from stovepipe run from each machine to a large

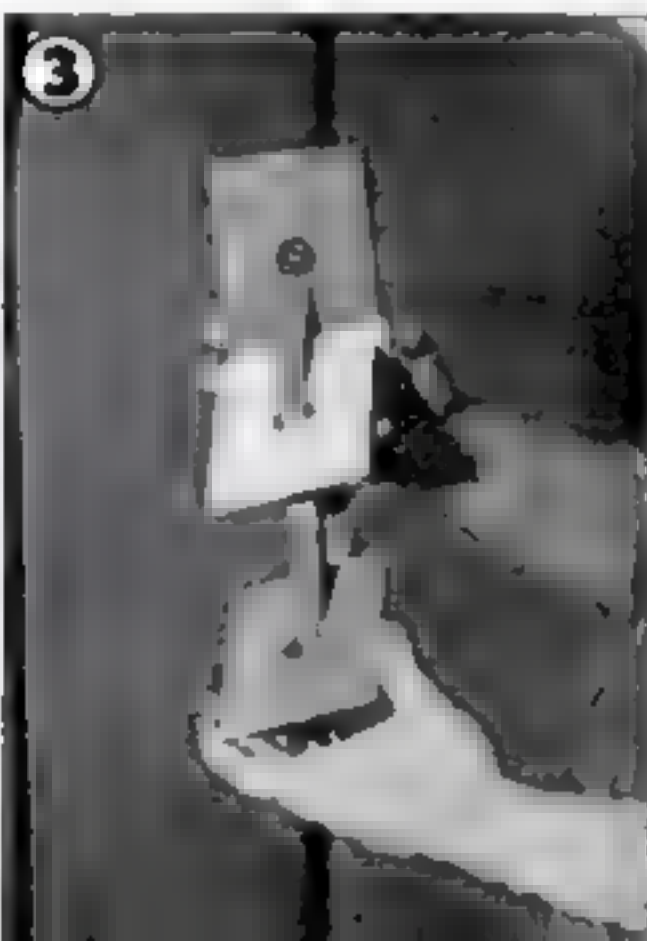
suction fan, which consists of an impeller made of maple and mounted on ball bearings, and located within a pine housing. Chips and sawdust are blown into a sheet-metal cone outside the building, there to be precipitated by their whirling action. Ingenious but simple valves, flat pieces of sheet metal sliding in wooden guides, control the suction at the machine in use.

Completeness verging on the lavish marks the equipment in Snyder's shop. There are two screw-cutting lathes, two wood-turning lathes that are also used for metal spinning, wood and metal-cutting bandsaws, drill presses, a spot welder, large and small belt sanders, and a 16" disk sander that Snyder built himself. Among the tools used for working sheet metal are a folder, a brake, a shear, a tube-rolling machine, and a beader. Snyder paints his work in a special spraying booth, and there is even an automatic oven for baking on finishes.

A compact printing plant in one corner of the shop permits Snyder to print his own instruction sheets, advertising material, and playing cards. The latter, ranging in size from tiny midget cards to the giant stage variety, are cut out on two small punch presses and printed with meticulous color registration.

Frequently in the course of his work Snyder must devise new techniques and special jigs. Most of these he keeps secret, though several are shown in the accompany-

TRICKS TO MAKE TRICKS are an important part of Snyder's stock in trade. In order to get the shallow longitudinal grooves in the pieces of wood used in this trick, he places the stock under a sander belt (1) and presses down with a stroking block. Edges are rounded (2) on a sander with a partly slit belt running on a form. The parts are strung together (3), and a piece is then magically freed (4)





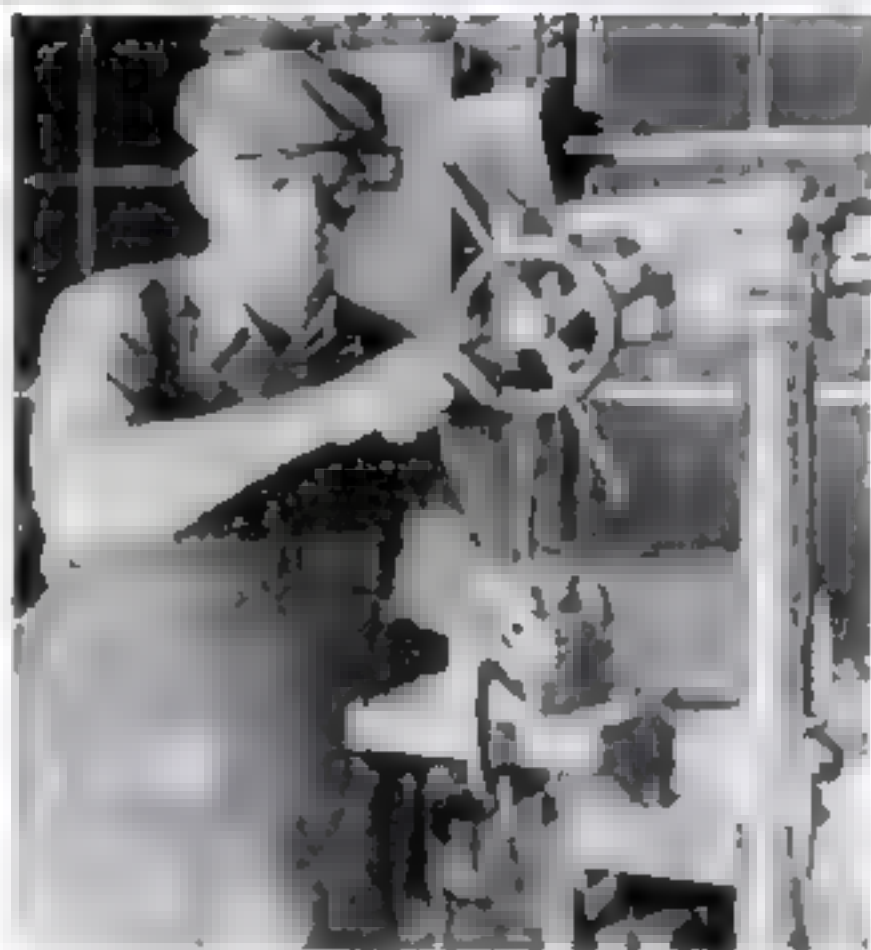
In a private theater that adjoins his shop, Snyder tests his new tricks before audiences of critical magician friends. At the right, he gives away one secret: a block, held in a V-shaped jig, is bored for a hole that will later be concealed by careful veneering. Snyder keeps most of his tricks hidden

ing photographs. One trick makes use of a block in which a hole is bored lengthwise. Another hole, large enough to hold a small marble, must be bored at right angles to the first but not through the outer wall of the block. Snyder bores through from an arria while the block is located in a jig. He then closes the hole by veneering the two faces so skillfully that no joint is visible on the finished piece

Adjoining the shop, which is near to but separate from his home, Snyder has built a small private air-conditioned theater. Here on a stage complete to drapes and lighting, he tries out new effects on an audience of friends, including both amateur and professional magicians. Afterward, his guests are served refreshments from a special kitchen built alongside the theater.

By no means all of Snyder's effects are for sale. There are in existence only two versions of his "ghost box"—a small, elaborately locked chest in which he places predictions of newspaper headlines for a specified future date. At the time set Snyder produces from the box headlines identical with those of the day's papers.

Once a stage magician who wished to



make selected cards appear between two sheets of plate glass in full view of the audience gave his problem to Snyder. The finished trick, which is now not on sale, consists of a picture frame on the base of which is mounted a photographic flash bulb. The sheets of plate glass are held together with a rubber band and placed between two uprights. When Snyder presses the button of a long photographic shutter release, the bulb flashes and the cards magically appear, sandwiched between the two pieces of glass. Certain parts in this equipment are built to an accuracy of .0001".



1 HERE'S A MAGIC BALL that will slide swiftly down a cord, or slowly if you give the magic word, and it will even stop on your command to mystify your friends! In addition to the magic word, of course, you tighten or slacken the cord unnoticed by your audience. It passes through a "gimmick"—as magicians call the secret device on which a trick depends—that is left in the hole as you insert the cord.

Use a solid wooden ball, one that can be turned from light stock or cut from an old ball-top newel post—or a square block may be substituted if you have too much trouble getting a suitable ball. Bore it through the center with a $\frac{3}{8}$ " bit; then carefully widen it from one end to the taper shown, using a large rattail file.

Two handles may be turned in the lathe or cut from whip or file handles. They also taper, as shown, so the gimmick attached to one with two tiny dowels will not be noticed. This lets the gimmick stick in the hole and enables you to control your trick.

Bore the handles and gimmick as shown, thread the cord through all three, knot the ends, and glue the cord to the handles. Paint the ball orange and its hole and the handles and gimmick black.—GEORGE BARR.

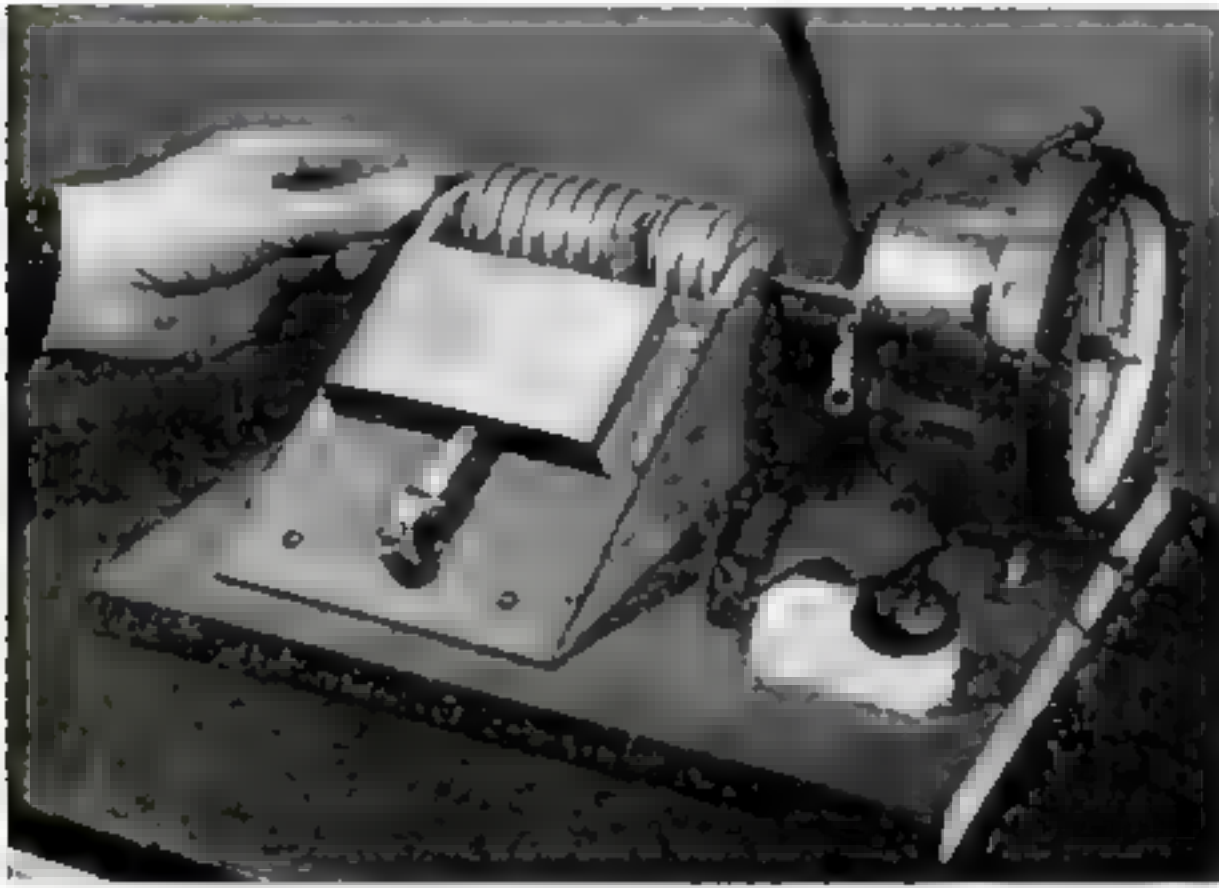
2 THIS TRAPPED HEART is a puzzle that will keep your friends racking their brains, yet it can be freed easily and without force—when you know how. Make the pieces from coat-hanger wire, scraping off the enamel and polishing it before forming the parts. Loops *B* and *E* will not pass through *C* and *D*, but *C* will just slip over loop *A* of the heart. Pull *C* over *A* as far as you can and push *B* all the way through *A*. Then remove *C* from *A*, and the heart will be free! To replace the pieces so the heart is again trapped, reverse the steps.—G.B.



3 THIS ONE FOR CHILDREN may also fool grown-ups, at least for a time. It should provide many hours of delight for youngsters of around kindergarten age. The object is to free the cord and button from the rest of the gadget. Simply push the cord through the ring and up the slot until it can be brought over one side of the handle and pulled free back through the ring. In fitting the $\frac{1}{4}$ " dowel in place, be sure it is in two pieces and does not lock the slot, or the trick won't work.—G. B.

Automatic Time Switch

CLOCK-DRIVEN DRUM CAN BE SET TO CONTROL ALMOST



By WALTER E. BURTON

FROM an alarm clock, a small drum, the arm of a discarded windshield wiper, and a few other odds and ends, you can construct a time switch for turning on and off a radio, poultry-house lights, a feed release for poultry or household pets, garage or barn lights, a window ventilator, an electric cooker, an electric sign, store-window lamps, or shop machinery. It will also operate relays to control heavy currents and high voltages.

The switch mechanism consists essentially of a grooved drum rotated, at one revolution per hour, by the time-setting knob of an ordinary alarm clock. Riding on the drum is a pin on the end of an automobile windshield-wiper arm or a similar lever about $6\frac{1}{2}$ " long. Attached to the lever is a spring-metal brush that moves across electrical contacts mounted on a composition-board panel with the lever. Two or more sets of contacts may be used, controlling in sequence more than one operation or circuit. Thus the device could be arranged to open the furnace draft at 6:00 A.M., turn on the coffee percolator at 6:30, and at 6:45 switch on the radio to awaken you!

A cylindrical wooden box $1\frac{1}{2}$ " to 2" in diameter and 4" to 5" long will make an adequate drum. Glue the lid on and drill it and the bottom in the exact center to receive a $\frac{1}{4}$ " by 7" rod that forms the shaft. A staple, run through a hole in the shaft and driven into the drum, serves to connect the two together. Strips of thin cardboard,

two layers thick, are glued around the drum in a spiral, as in Fig. 1. For 12-hour operation, they should be $\frac{3}{32}$ " or $\frac{1}{8}$ " wide for a drum of this size, and the groove between them should be the same width. A better job can be done in a lathe with wood, metal, or plastic by cutting coarse-pitch square or V threads. It is possible in this way to make a highly accurate drum that will operate 24 hours or more.

Mount the drum and clock on a base, as shown in the photos, with the time-setting knob and drum shaft in line. A simple coupling,

made as shown in the drawing and in Fig. 2, joins the knob to the shaft. Be sure the drum turns without much resistance, or the clock will stall.

A windshield-wiper arm having a built-in pressure spring makes an ideal lever, or one may be fashioned from a strip of metal or even wood. Arrange some kind of spring so the free end will be forced down against the drum. At this end rivet a short pin that will slide easily along the drum groove without too much side play (Fig. 2).

The contact brush is a piece of thin, springy brass or bronze bent once around the lever, insulated from it by a layer of mica or other nonconductor, and projecting $\frac{1}{8}$ ", as show in Fig. 3 and in the drawing.

Strips wound side by side on the drum will make a perfect spiral groove if one is glued on and the other is used as a spacer. Glue another strip on top for double thickness and finish with lacquer



Has Scores of Uses

ANYTHING ELECTRICAL IN THE HOME OR ON THE FARM

This projection is split for $\frac{1}{2}$ " to form two fingers that can be bent to press firmly against the panel. The brush is held to the lever by a C-shaped clamp made from sheet metal.

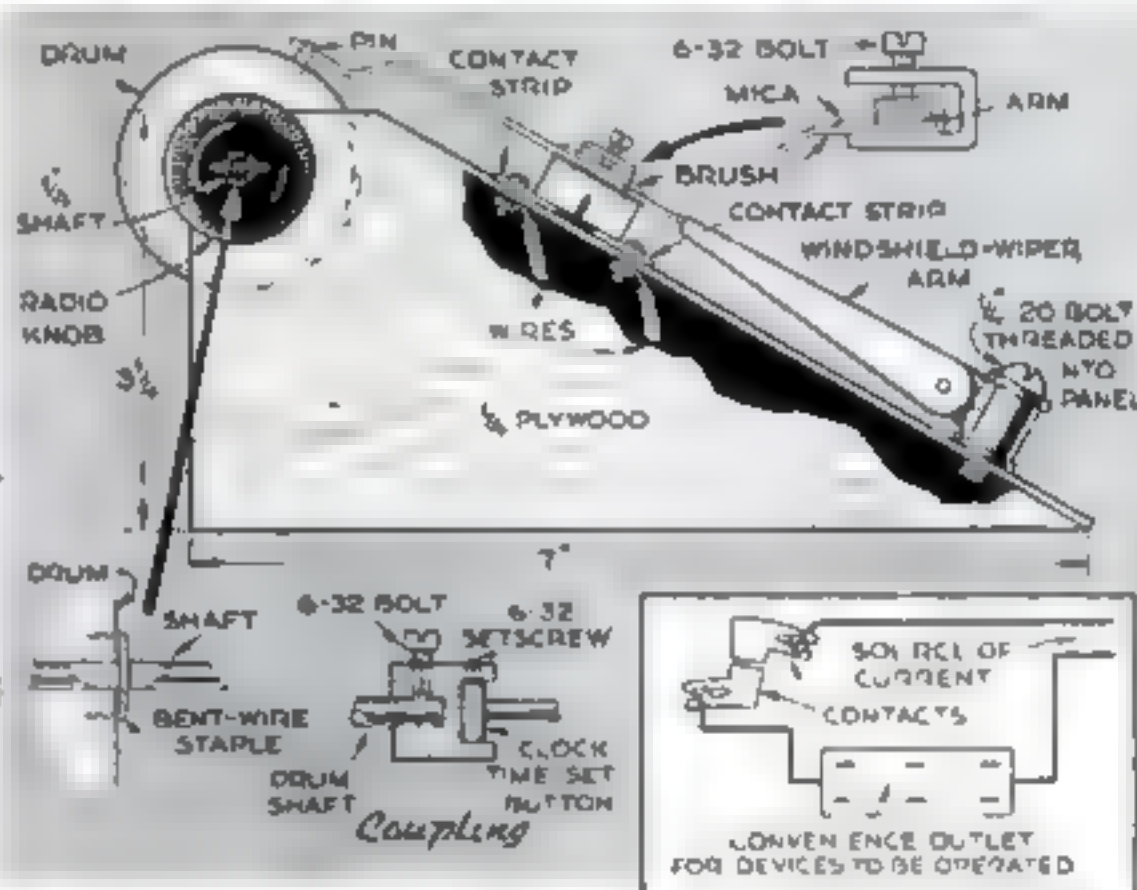
Cut the contacts from thin brass, bronze, or tin-can stock, and bolt them to the panel. Figure 3 shows only one set, but you can mount several pairs to control additional circuits, and you can also fasten more than one brush to the lever for handling still more circuits. The contacts in Fig. 3 are slotted so they can be shifted to vary the timing. By moving the lower contact to the left, the turn-on time is put ahead; by moving the top contact to the right, the turn-off time is set back. The wiring diagram for the circuit is given in the drawing.

A removable shield installed over the panel will prevent accidental touching of the live parts of the mechanism. One made of wire screening will allow you to see the contacts and brush.

To put the timer into operation, set the clock minute hand to the fraction of the hour the circuit is to be closed; then place the lever pin in a groove far enough from the end to permit sufficient "on" time after the circuit is closed, and adjust the contacts so the brush will just touch them at this point. For exact timing, loosen one

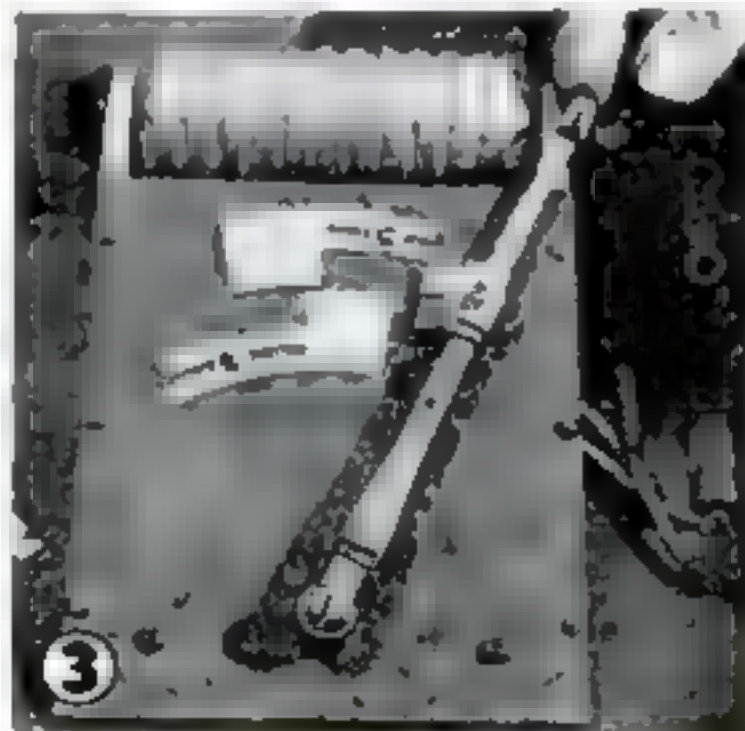
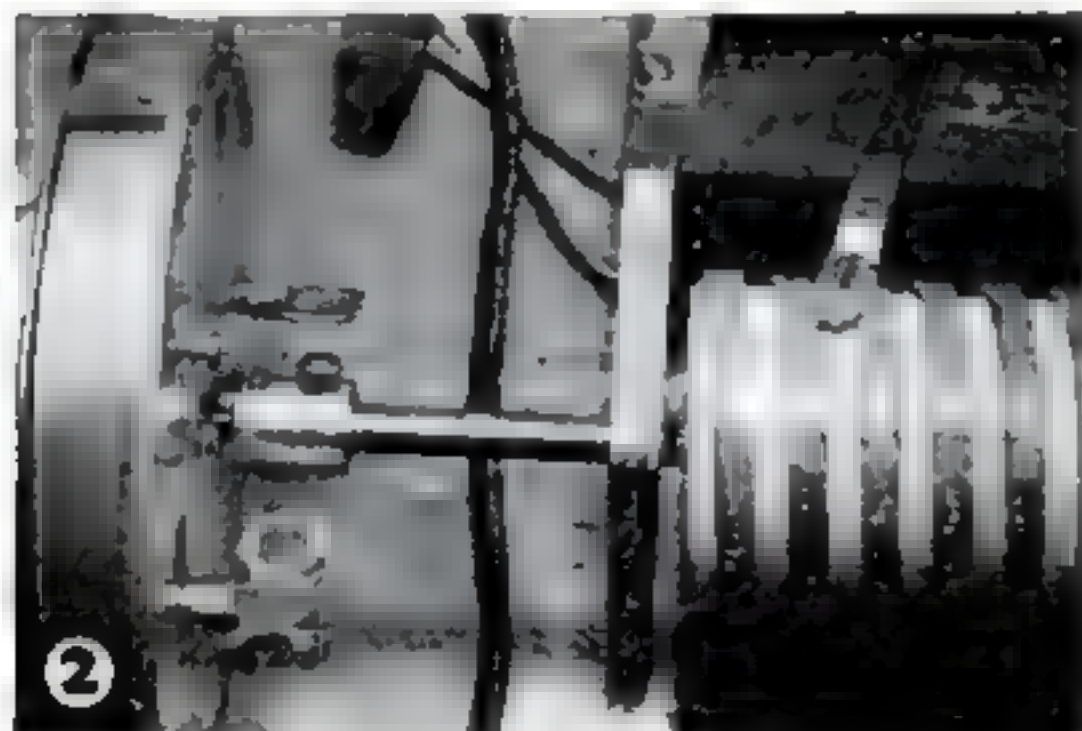
of the setscrews in the coupling and, with a lamp plugged into the convenience outlet, turn the drum until the lamp lights; then tighten the setscrew. After these adjustments, the clock is set for the correct time and allowed to run normally. Then to set the timer so it will close the circuit after a definite interval, say five hours, move the lever pin five spaces (grooves) from the clock toward the starting end of the revolving drum.

When the current draw is heavy, such as that for an electric roaster or a large motor, the switch circuit should not be connected directly. It is much safer to have it control a low-voltage relay that in turn handles the heavy-current circuit.



Joined to a shaft by a simple coupling, the time-setting knob turns the drum at one revolution per hour. As a pin slides in the groove, a lever to which it is attached is in turn moved slowly across the face of the contact panel

Here are the contacts on the time-switch panel. The brush on the lever arm closes the circuit when it touches both contacts and opens it again when contact is broken





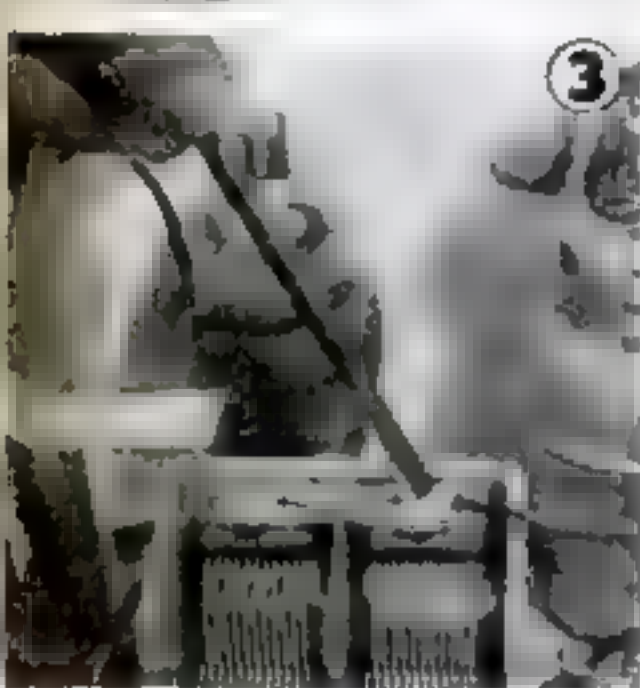
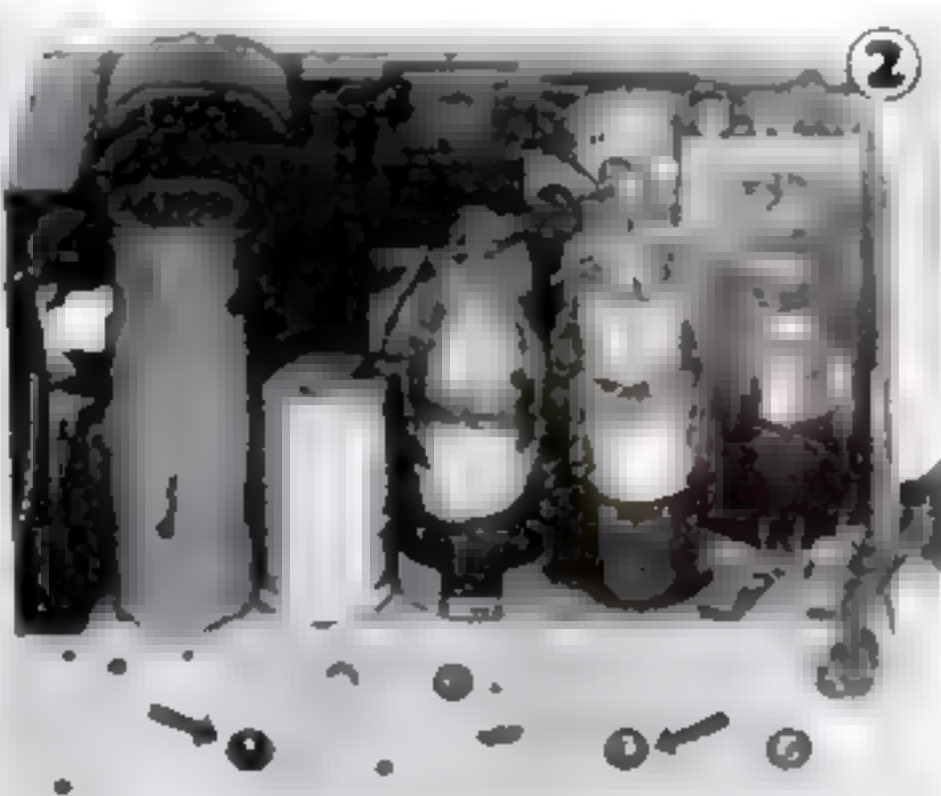
TUNING IN THOSE

Servicing Your Radio

OLD radio receivers that can't be tuned in clearly on stations at the high-frequency end of the dial can be adjusted more or less simply. How this is done is of particular interest because of the addition of stations at this end of the dial when all frequencies were changed not so long ago.

In making the adjustment, however, a compensating loss is to be expected at the low-frequency end. Those who prefer stations at the low end of the dial may be better pleased, therefore, to leave the adjustment as it is, though in many cases it is possible to get satisfactory reception at both ends.

Usually the radio will have to be lifted from the cabinet to make the adjustment. This is done by first removing the tuning knobs and then taking out the small bolts at the bottom. Often the chassis will bear a label telling



OFF-THE-DIAL STATIONS

whether the circuit is superheterodyne or tuned radio frequency (T.R.F.). These two general types require slightly different treatment, but if you can't find out which yours is, handle it first as a superheterodyne.

The tuning condensers of many superheterodynes are located on the chassis in the position shown in Fig. 1, and are shunted with small trimmer condensers, indicated by the two arrows marked 1. These trimmers are not always located on the main tuning condenser, however. Some may be placed underneath the chassis and can be reached from the rear as indicated by the two arrows in Fig. 2.

Mark on the trimmers the position of the slot in the holding screw, and open one of the screws a one-eighth turn (Fig. 3). Have the antenna attached and the radio turned on so any change in reception can be noted. When the oscillator trimmer is opened up in this way, all stations on the dial will be moved up several points. The screw can then be turned back slightly, or opened up still further, until satisfactory reception of the high-frequency stations is obtained. Test stations at both ends of the dial, and insulate the handle of the screwdriver so reception will be as nearly as possible the same as you will get when the set is returned to the cabinet. If nothing happens when the screw is turned, the trimmer should be closed up again by returning the screw slot to its original position, and the same opening turn should then be given to the other trimmer screw. After the adjustment has been completed, the trimmer should be sealed with a drop of sealing wax so vibration will not open it further.

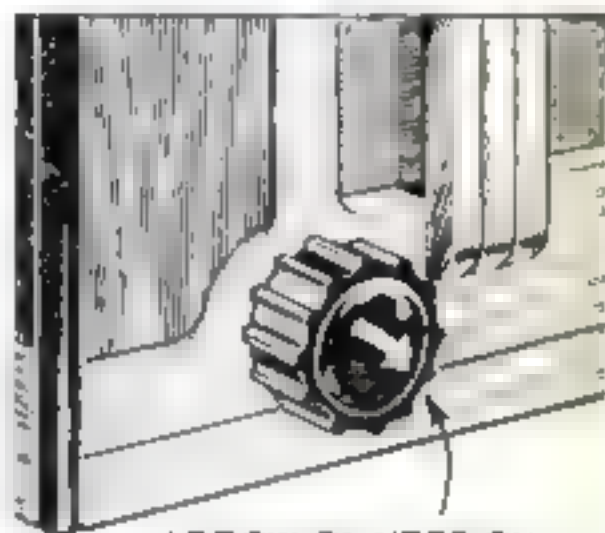
T.R.F. adjustment is a little more complicated. Mark the trimmers as before, and open them for a test one after the other until the detector stage is reached and the stations shift on the dial as in the case of the superheterodyne. If no single trimmer causes this, open the trimmers in groups of two so as to cause a greater capacity change, choosing any two and opening them up equal-

ly. Should this still not produce the desired change, try bending the outside plates (shown at 3 in Fig. 1) of the main tuning condensers with a pair of long-nosed pliers, as in Fig. 4. Make the test on one condenser in the gang at a time.

When all these capacity-changing methods fail, the value of one or more of the inductances may be lowered in order to achieve the desired result. Insert a 1/16" by 1/4" by 4" piece of copper in the center of any one of the inductances, as in Fig. 5, while the main tuning gang condenser is turned to its highest setting. At some definite point of insertion, the high-frequency stations will begin to come in, and a little tuning will sharpen them. Insertions may be tried in all the inductances to determine which produces the best results, after which the copper piece can be attached permanently to the coil with a small screw or a drop of sealing wax.—TRACY DIERS.

Arrow on Control Knob Will Gauge Volume

A SMALL arrow painted on the volume-control knob, as shown at right, will enable you to turn the radio to nearly the volume desired without waiting for the tubes to warm up. On occasion it may also indicate a weakening battery or other loss of volume that might not otherwise be noticed until serious trouble occurs.—BLANCHE PORTER.



ARROW PAINTED ON VOLUME-CONTROL KNOB

Clip on Lid of Portable Holds Radio Data

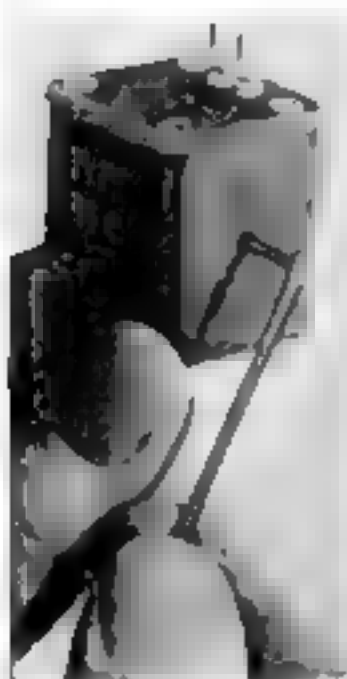
SPACE behind the lid or door that protects control knobs of some portable radios can be utilized by attaching a strip of springy metal, bamboo, or wood. Round the free end of the clip so program lists, other papers, or booklets will slip under it easily, and mount where it won't interfere with the knobs.—W. E. B.



radio ideas

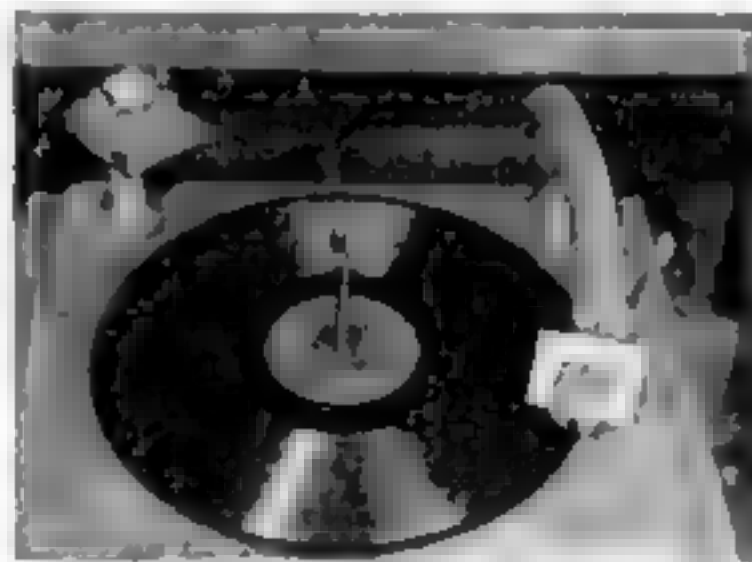


ELECTRONIC HEATING now sets the twist in rayon tire cord, following the development of a process that involves high-frequency power units with outputs of 22,500 B. T. U. per hour. Cones of cord, weighing 18 lb. and wrapped in moistureproof paper to keep moisture in, are processed in a matter of minutes. They are placed in a high-frequency field where heat is distributed evenly in each cone and sets the twist uniformly. In the photo, the operator at right is removing plywood covers from cord emerging from a heating unit, and the one at left is packaging cones for shipment. The process, developed by the Industrial Rayon Corporation, is used in its Cleveland plant and by B. F. Goodrich Company.

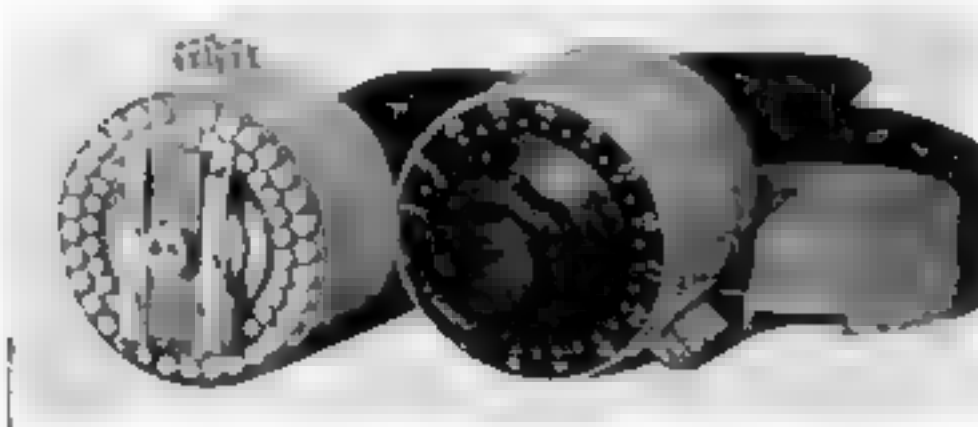


VARIABLE INDUCTORS for peaked amplifiers, filters, oscillators, and equalizers are now available on priority. They are the result of research begun four years ago by the United Transformer Co., of New York, on a method of varying the inductance of coils employing magnetic cores. Inductance variation of plus 90 percent, or 50 percent from a mean value, is possible. It is controlled by a screw, or an extension rod if remote control is desired.

EMERGENCY SUBSTITUTIONS of tubes in civilian radio receivers are listed in a new RCA directory prepared especially for radio servicemen but available also to the public. More than 2,000 tube substitutions are listed for quick reference along with notations on space limitations and changes that may be required in wiring, filament and heater circuits, and sockets.



ATTENUATORS for precision volume control are now equipped with a new detent gear, contacts and switches of tarnishproof silver alloy, and a new-type steel cover that improves magnetic shielding. These resistive networks, shown below, are made by The Daven Company, of Newark, N. J. They are used to control one or more programs coming into a studio, to fade programs in or out, to monitor outgoing programs, for speaker control in P.A. systems, and in test equipment.



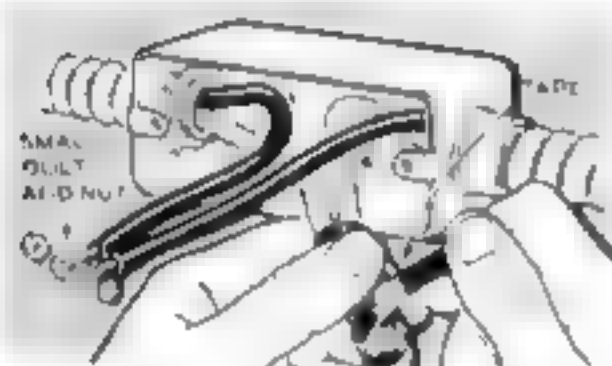
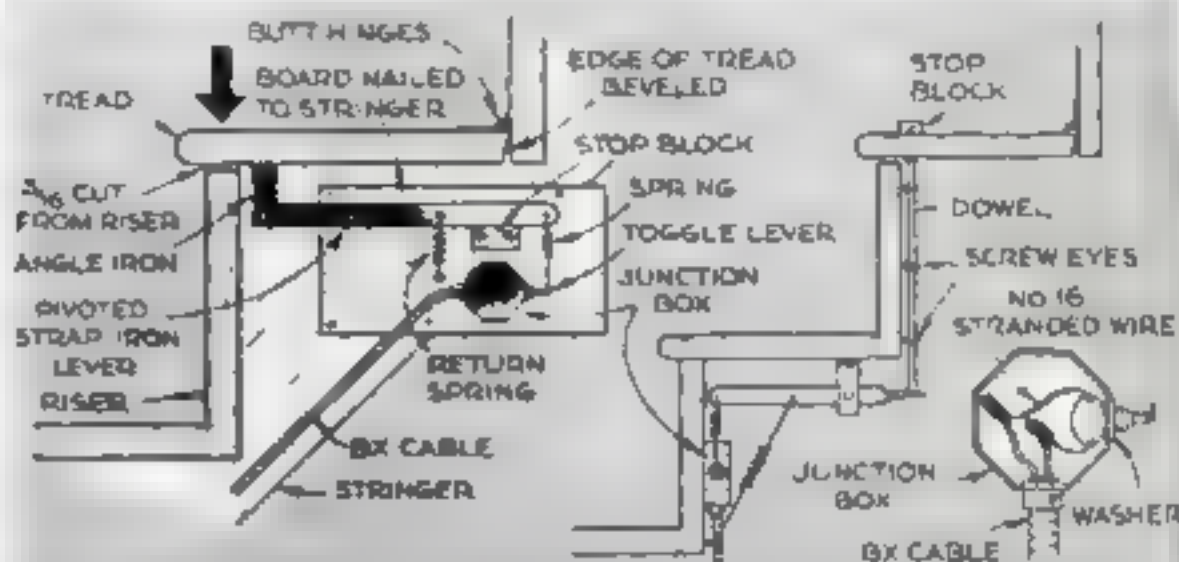
RECORDS ARE CLEANED while they are played with a new device—a chemically treated felt pad that fits on the tone arm of a phonograph and takes up dust and needle scrapings as it travels along over the record. Grit and grime adhere to the surface of this novel record-cleaning pad instead of remaining in the grooves and hastening wear. Six general types of pads are available to fit various makes of record players. They are a product of the Recordit Company, of St. Louis.



Basement Light Switch Operated by Stair Tread

LIGHTS in a cellar can be turned on automatically when your arms are full simply by stepping on a stair tread if you rig up a toggle switch and lever under the stairway in either of the two ways shown below. Since toggles open and close alternately, you also turn the lights off as you step on the tread in leaving.

The riser below this tread is cut down slightly, the back edge of the tread beveled, and the tread itself hinged to the riser above it in both setups. Also in both a stop block keeps the hinged tread from rising dangerously if you catch your toe. Use a 3" junction box connected to the light by BX cable, and join the toggle to the lever with a spring to avoid breakage.

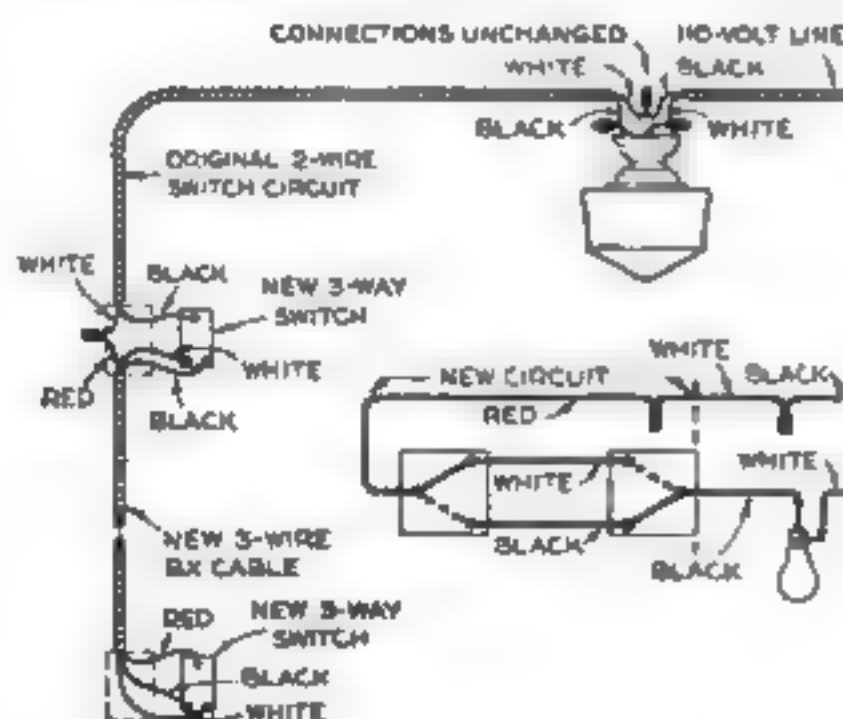


Bolt Holds Cables in Temporary Splice

WHEN removing a switch or receptacle plug from a wall box and connecting the cable leads to keep the circuit intact, bolt the wires together and tape the juncture. Twisting may cause the wires to break and shorten them, hampering efforts to reinstall the switch, especially if the job has to be done again.—J. M.

WIRING THREE-WAY SWITCHES

[ELECTRICAL]



To substitute two three-way switches for a single-pole switch on a stairway or in a large room having two entrances, run a three-wire cable from the old switch location to the point selected for the second switch and make the connections as shown in the drawing. The connections to the light remain unchanged.

After removing the old single-pole switch from its box, pry out a knock-out disk in one end of the box. If necessary drill a small hole at the edge of the plugged opening to permit insertion of a tool to lift the disk or blank. Carry the cable from this opening to the other box by the usual method of fishing wires in a wall.

POPULAR SCIENCE MONTHLY SHOP DATA

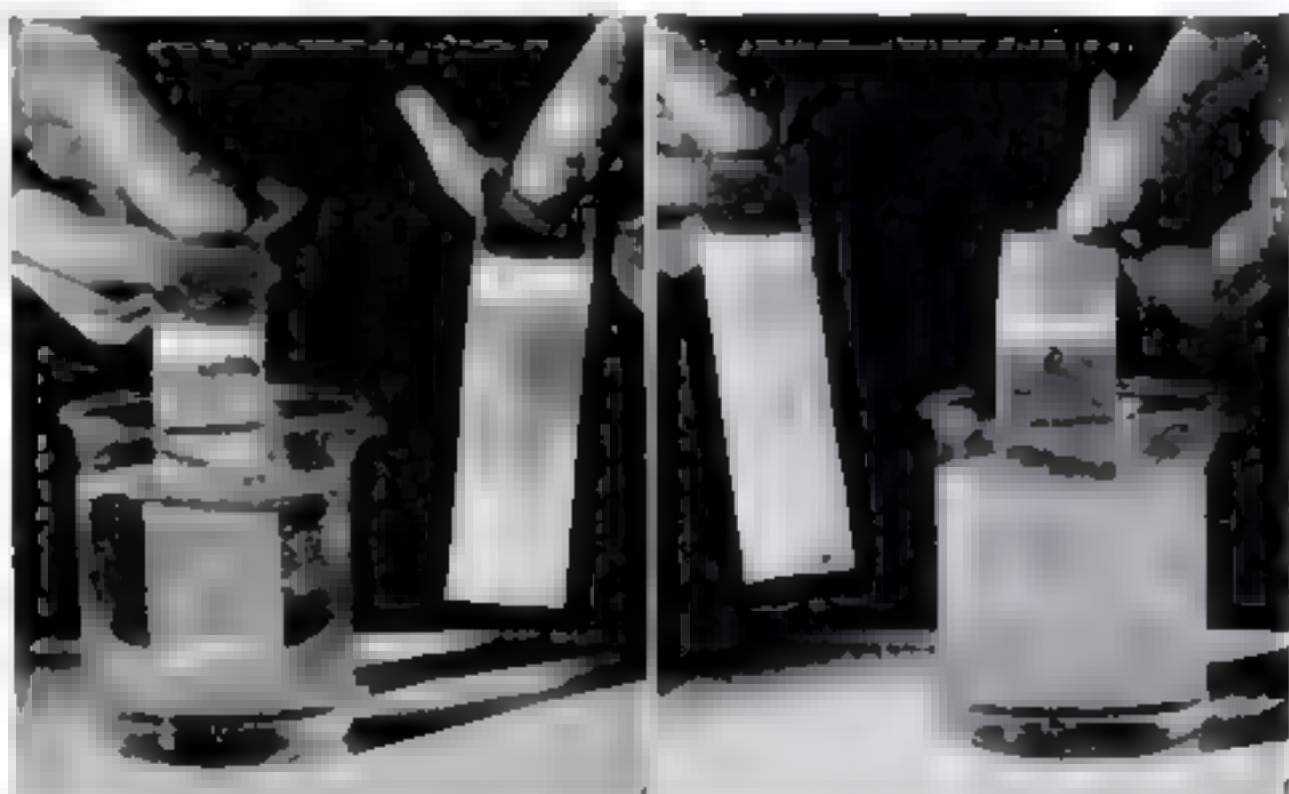


A TWO-CENT BATTERY that embodies the fundamental principle of all primary electric cells is easily made. Press a "red" copper cent against one side of a piece of blotting paper saturated with salt water, vinegar, or citrus juice, and press one of the new zinc-coated cents against the other side. Wind several dozen turns of fine, insulated copper wire around a pocket compass so the coil parallels the direction of the needle. If you hold one end of the wire against the copper cent and the other end against the zinc-coated cent, the needle will swing widely. Reverse the wires, and the needle will swing the other way.

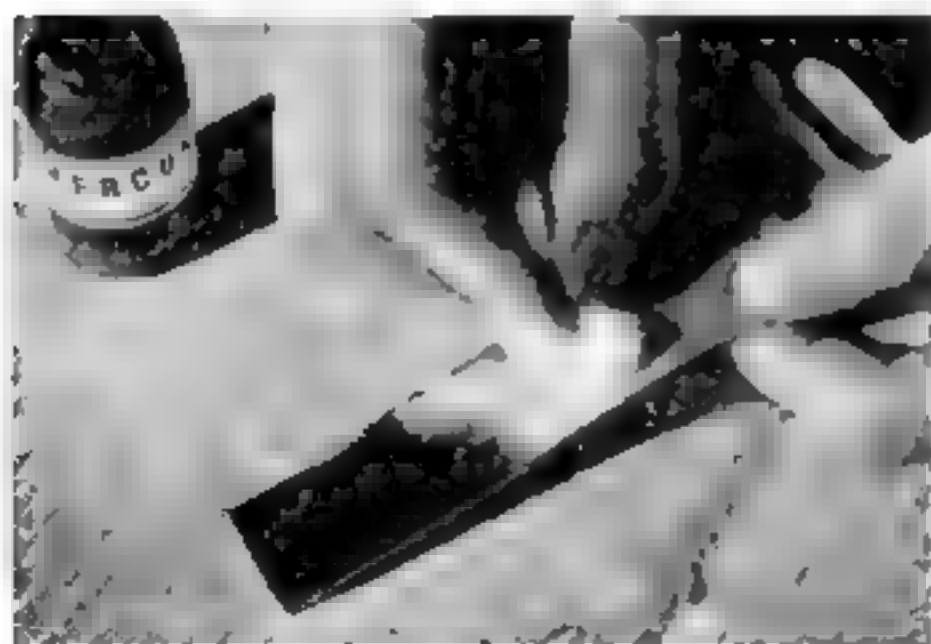
NEGATIVE and positive plates separated by a conducting liquid constitute the elements of all primary cells. When the plates are connected externally by a wire, an electric current flows through the wire as the result of a continuous chemical action in the cell. Dissimilar metals, or carbon and a metal, are necessary for the plates, because the difference of electrical potential between them is determined by the action of the liquid on the plates. The negative plate is always the one that is acted upon most, while the positive plate is the one least acted upon by the liquid.

In order to observe the action of a battery solution on the plates, make such an electrolyte of 1 part sulphuric acid added to 10 parts water. Always be careful to pour the acid into the water slowly while stirring; never pour water into the acid.

Now dip a small strip of clean copper into this solution. The copper may be brightened,



but no further action will take place. Dip a similar strip of ordinary commercial zinc into the solution, and the zinc will begin to dissolve immediately, liberating hydrogen gas from the acid. If this solution and these plates were used in a battery cell, the zinc would form the negative plate—and would be acted upon most—while the copper strip would serve as the positive one.



ZINC IS COMMONLY USED for the negative plate of both wet and dry cells. Chemically pure zinc would be acted upon only when current is drawn. However, ordinary commercial zinc contains impurities that act as positive elements and so create minute local currents on the surface of the metal, which is therefore eaten away even when no current is drawn. To minimize this, the zinc plate is first cleaned in dilute acid and then amalgamated—rubbed with a small amount of mercury. This forms a coating of zinc-mercury alloy that prevents local action and acts like pure zinc.

CHEMICALS GENERATE ELECTRICITY

BEND ONE END of a copper plate and an amalgamated zinc plate and hang the plates over opposite sides of a tumbler containing dilute sulphuric acid, and you will have a simple battery cell. Provide binding posts and connect the cell to a $1\frac{1}{2}$ -volt flashlight bulb. It will light brightly and then, after a few seconds, will go out because hydrogen bubbles accumulating on the copper plate increase resistance so greatly that they practically stop the current. This action is called "polarization." Wipe off the copper plate, and current will flow again.

"DEPOLARIZERS" ARE EMPLOYED to remove hydrogen by oxidizing it as soon as it is generated. Add some potassium bichromate to the solution in your cell, as shown below, and your light will burn brightly and continuously.

The cell you have made is known as a "wet" cell. You can make a "dry" cell by using a porous material to absorb your battery solution. Cut the metal or sealing-wax top from an exhausted flashlight cell, remove the carbon rod (right, below), clean the inside of the zinc casing, and reline the sides and bottom with blotting paper. Then fill it with a mix of 2 parts ammonium chloride, (the electrolytic agent), 75 parts manganese dioxide powder, and 25 parts graphite powder (depolarizers), and add just enough water to make a thick paste



VOLTAGE AND SIZE have little in common—it is the type of plates and solution that counts in a battery cell. With half a test tube of solution, you can make a cell that will produce 2 volts compared to the $1\frac{1}{2}$ volts of most dry cells. Use a small glass for the container, the carbon from an old flashlight cell for the positive plate, and a strip of zinc from the same battery as the negative plate. For a solution, dissolve 3 grams potassium bichromate powder in 16 ml. hot water and let it cool; then, stirring constantly, add carefully 3 ml. concentrated sulphuric acid to complete the electrolyte.





Cinnabar heated in the horizontal tube in this setup decomposes into metallic mercury and sulphur dioxide, the latter escaping as a gas

Mercury

... THE LIQUID METAL

**Important Alike to Science, Medicine, and Industry,
This Fluid Element Is So Heavy That Iron Floats in It**

By KENNETH M. SWEZEY

MERCURY, the only metal that is liquid at ordinary temperatures, solidifying at its freezing point of -39 deg. C., is one of the most fascinating elements. Because of its wide distribution and the simplicity of its metallurgy, it was known to the ancients. It was the principal substance the alchemists believed could be changed into gold and silver. Since then it has found wide use in medicine and in the arts.

Both the common term "quicksilver" and the Latin chemical name *hydrargyrum*,

"water of silver," eloquently describe the elusive liquid metal that does not wet glass and that is so heavy that iron nuts, bolts, and washers float in it like corks. Because of its weight, mercury is an ideal liquid for barometers and suction pumps. Its high boiling point (357 deg. C.) and even thermal expansion make it a fine fluid for thermometers. Although mercury actually can be changed into gold now by the miracle of atom smashing, the transmutation will never make anyone rich, for the cost far exceeds the value of the final product.

Most mercury is obtained from cinnabar,

a naturally occurring red sulphide (HgS), by roasting in air to vaporize and then condense the mercury. This may be demonstrated by mounting a 1" by 10" or 12" hard-glass tube as shown in the photo on the facing page. Place powdered cinnabar or mercuric sulphide in the center, and keep it in place with a loose plug of asbestos or glass wool on each side.

Connect one end of the tube to an outlet tube in the stopper of a gallon bottle that is also connected to a water supply. Plug the other end with a stopper fitted with a bent glass tube. Insert this bent tube in a tumbler of water containing several drops of sulphuric acid and enough potassium permanganate to color it a pale violet.

After making sure all connections are tight, heat the center of the tube strongly. Then allow a small stream of water to run into the bottle. This forces a slow current of air through the roasting tube, causing the generated gases to bubble up in the tumbler. The solution will lose color slowly, revealing that one of the decomposition products of heated mercuric sulphide is sulphur dioxide. The other, metallic mercury, condenses in tiny globules in the cooler parts of the roasting tube.

Metallic mercury is not poisonous, but its vapor is quite poisonous. Mercury therefore should never be heated in an open vessel. All soluble mercury salts are also poisonous, and they should be handled with

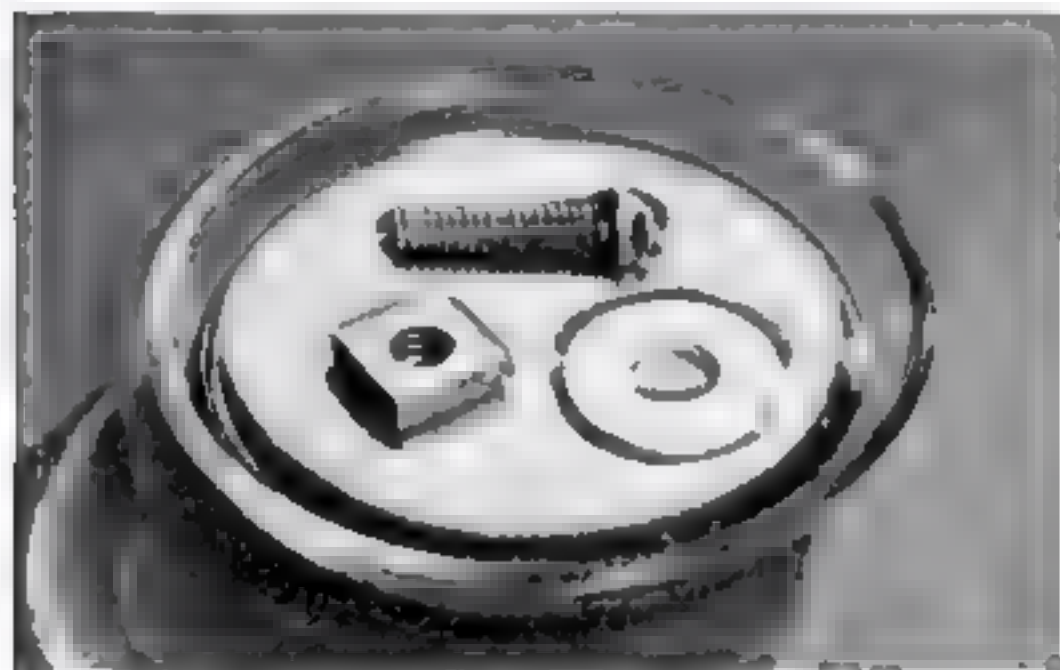
care. Keep them away from your mouth and food, clean up immediately any you spill, and wash your hands thoroughly after handling them.

Familiar compounds are insoluble mercurous chloride, or calomel—used largely as a purgative—and its deadly companion, mercuric chloride, better known as corrosive sublimate or bichloride of mercury. Despite its potential deadliness, mercuric chloride is also a powerful antiseptic. Because light can decompose calomel into dangerous corrosive sublimate, this medicine is kept in dark bottles.

The white of an egg, mixed with a little water and administered quickly, is one of the best first-aid antidotes for mercury poisoning. Mercury salts precipitate albumin, forming a bland, insoluble substance that takes the remaining salt "out of circulation." To demonstrate the reaction in a test tube, pour diluted egg white into a solution of mercuric chloride or nitrate. A hard, insoluble precipitate will form and remove the mercury from solution.

Mercury has the strange property of uniting directly with most metals and a number of other elements to form compounds and alloys. Grind metallic mercury with powdered sulphur, and the substances unite as black mercuric sulphide. Iodine crystals ground with mercury produce red mercuric iodide.

An alloy of mercury and another metal is



Mercury is so heavy that nuts, bolts, and washers float in it like corks. It combines directly with ordinary metals except iron and platinum. Ground with sulphur powder, as at the left below, it will form a black mercuric sulphide

Dipped in mercuric chloride solution, a strip of polished copper is quickly coated with mercury. Alloys of mercury and other metals are called amalgams



PHARAOH'S SERPENTS are the ash of the mercury compound, mercuric thiocyanate. A pellet lighted on the tip sends out an ash that writhes and twists like a live snake. This amusing substance is made by pouring a solution of potassium thiocyanate slowly into a solution of mercuric chloride. The precipitate is dried and made into a paste



jewelry. If a metal article can be heated safely, however, the mercury can be driven off by heating it carefully over a medium-low flame.

called an "amalgam." The "silver penny" that boys make by rubbing mercury on a clean copper cent is the result of amalgamation. Zinc rods of wet primary batteries are coated with mercury to provide an alloy surface that acts as if it were pure zinc. Plastic amalgams of mercury and silver or gold are used as dental fillings, their plasticity controlled by the amount of mercury. Surfaces of metal objects may be amalgamated with mercury also by dipping them into a solution of a mercury salt.

Because mercury will unite directly with every ordinary metal but iron and platinum, those working with it must be careful not to let it touch their gold or silver rings or other

fully over a medium-low flame.

One of the most spectacular salts of mercury is mercuric thiocyanate. Pellets of this salt are known as "Pharaoh's serpents." Lighted at the tip, they produce a voluminous ash that curls grotesquely like a live snake. You can make mercuric thiocyanate by slowly pouring a strong solution of potassium thiocyanate into a solution of mercuric chloride until the formation of a white precipitate stops. A few drops of a solution of iron chloride in the original mercuric chloride solution will show the completed reaction better. Stir this mixture constantly while adding the potassium thiocyanate, and stop pouring when it turns a stable pinkish

hue. The white precipitate that settles to the bottom should be washed by decantation. Pour off the clear upper solution, add fresh water, shake, allow it to settle, and again pour off. Repeat these steps several times. The remaining precipitate is spread on glass to dry without heat. Work the dry powder into a stiff paste by adding a little water containing a few drops of mucilage and a few grains of potassium nitrate. Then mold the paste into little conical pellets and let them dry thoroughly.



AS AN ANTIDOTE for mercury poisoning, the white of an egg has long proved effective. How it works is shown by pouring a little egg white into a solution of mercuric chloride or mercuric nitrate. Albumin will be precipitated, forming a bland, insoluble substance that will remove the mercury from solution.



Versatile but complicated, this harvesting machine is one of the farmer's greatest labor-saving devices

Keeping the Combine on the Job

CAREFUL MAINTENANCE HELPS TO INSURE A GOOD HARVEST

By E. W. LEHMANN

Head of Agricultural Engineering Department,
University of Illinois

ALTHOUGH the combine harvester was developed in the Middle West 100 years ago, it was not until farmers began to grow soybeans in Illinois and demanded the combine for harvesting the new crop that it came into general use. From the soybean fields, the machine went naturally to the harvesting of wheat and other cereal crops. Now it is used also for harvesting field peas, sorghums, clover, and grass seeds throughout the United States. A few farmers have even tried it on field corn with fair

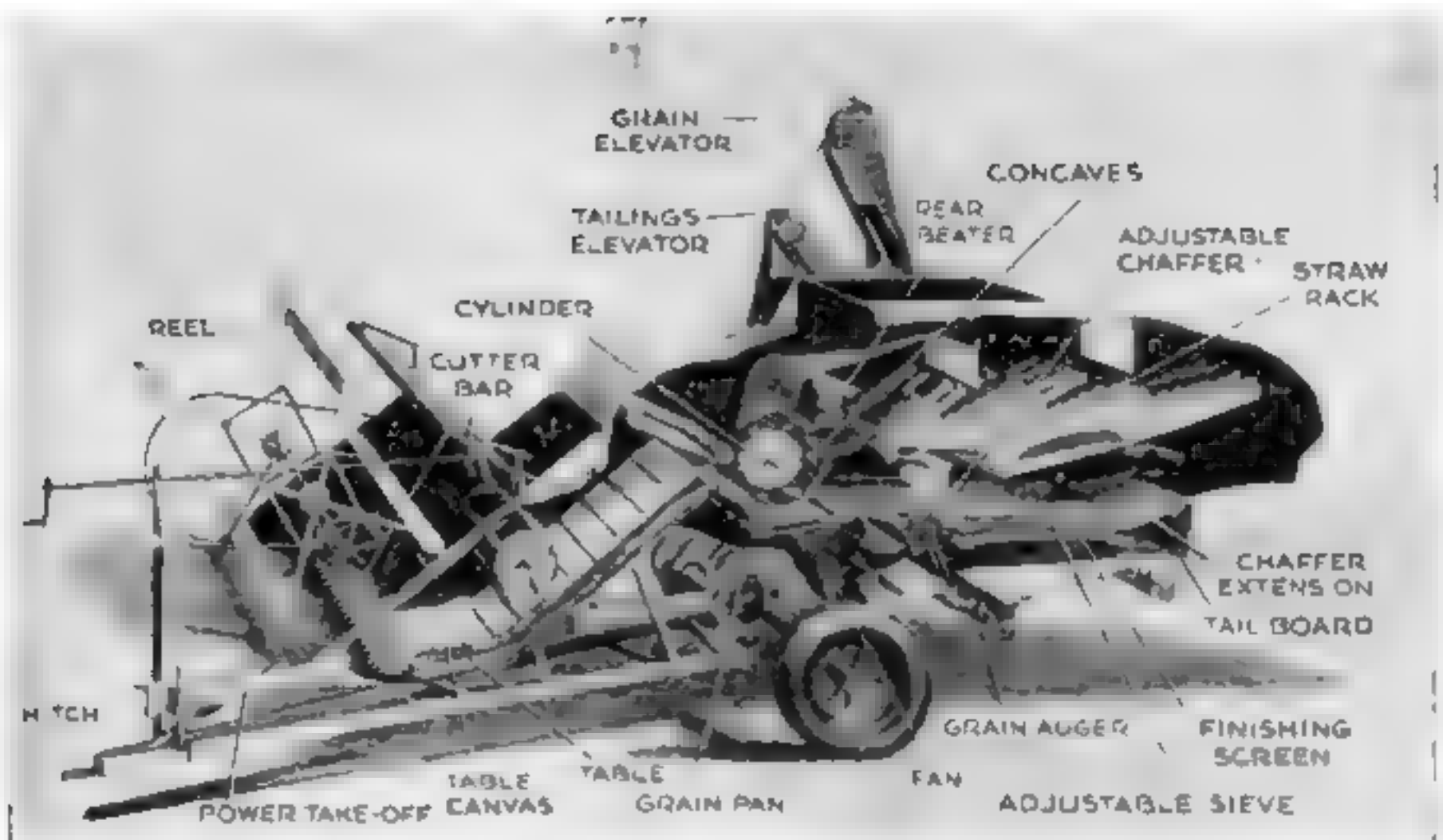
The combine is one of the most versatile of harvesting machines and has been a factor in reducing the labor needed to produce beans and small-grain crops. This makes it all the more evident that, with limited new machines available, the careful maintenance and proper use of a combine are more essential during wartime than ever before. To harvest the nation's crop of 10,500,000 acres of soybeans during a comparatively short period, all our combines must be in first-class condition. Last year many thousands of acres of this essential crop were lost be-

cause bad weather, along with a shortage of both labor and machines, prevented harvesting. In some instances, the available machines were not in condition to get the job done at the proper time.

The number of days in which harvesting with a combine can be done is always limited. Loss of a few hours due to waste of time in making repairs when the field job should be underway could result in the loss of an entire crop.

A good combine operator not only is thoroughly acquainted with the requirements of the job of harvesting a particular crop, but also knows his machine and the adjustments needed for different crops. Three operations occur in harvesting with a combine: cutting the grain, threshing it, and separating it from the straw. The straw is discharged at the back of the machine, and the grain is delivered into a tank or into a wagon or truck alongside the machine. Thus the combine is a combination of a binder and a threshing machine with some of the features of each eliminated and other features added to make it a mobile machine that does the complete job.

In the maintenance and operation of a combine, the parts to which particular attention should be given are the cutting



Cut-away drawing of a typical combine harvester, showing the location of the parts that need servicing

mechanism, the facilities for transporting the cut grain into the threshing unit or cylinder, the cylinder itself, the grain and straw separating equipment, and finally the elevator for delivering the grain.

The cutting mechanism is not greatly different from that of a mowing machine or a binder. Special reels are sometimes used to make cutting easier and to deliver the cut grain or other crop onto the platform and canvases that carry it into the cylinder.

Both the cutter bar and guards should be checked in detail to see that the sections are timed and sharpened. Less power is required and the crop can be cut with less difficulty when the knife or sickle is in good condition. Each knife section should be checked, and any that is badly worn should be repaired or replaced. The knife clips, wear plates, and guards must be adjusted to permit the knife to operate without binding. Each guard should be checked to see that it is in proper alignment, and if it is not, it should be straightened with a hammer or replaced.

The cutter bar is driven by a pitman, the bearings of which are subject to wear. Any looseness might result in damage or breakage if not corrected. The bearings should be tightened if there is too much play, but care must be taken to see that they do not bind in operation. This procedure of checking the pitman that drives the knife or sickle applies also to the pitman that operates the straw rack or other parts of the machine.

Canvases are subject to deterioration. They should be protected from the weather,

and it is best to remove them from the machine when it is not in use. All slats on the canvases should be kept tight, and tears or worn parts should be repaired immediately to avoid more serious damage. The canvases must be checked on the rollers for true running. If a canvas does not operate square with the roller, there is danger of ripping the slats off when they get in a twisted or a diagonal position.

The main parts of the threshing mechanism are the cylinder and concaves. Because of its relatively high speed and its comparative heaviness, the cylinder must be kept in perfect balance to avoid excessive vibration with resultant damage to the bearings and possible failure of the entire machine. Broken cylinder teeth that are replaced may cause a cylinder to get out of balance. The same is true of the collection of dirt on the back of cylinder bars. In replacing either cylinder teeth or cylinder bars, the cylinder should be checked for balance and corrected when necessary by weighting.

Bearings and hangers supporting the straw racks and cleaning chute—the principle parts of the separating mechanism—require the most attention. All bearings in a combine should be checked occasionally for wear, and they must be kept properly lubricated at all times. The racks, screens, and sieves should be kept clean and in good condition, for sieves and screens that are filled with straw and weeds will not function properly. Selection of the proper size of screen for the particular crop being harvested is essential.

The grain elevator and the elevator for discharging the tailings, that is, the dust, dirt, and waste wheat seeds, should be adjusted with a limited amount of slack, but they should neither be too tight nor too loose. Broken or lost paddles or slats should be replaced on the chains, and the condition of the bearings should be checked.

Rain and sunshine are both harmful to belts, and therefore these parts, under most conditions, should be removed from the machine and stored when the harvesting season is over. Adjust the belts tight enough to prevent slipping on the pulleys during operation.

Check the gear box to see that it is properly filled with lubricant of proper grade. In operation never engage the gear-box clutch when the shaft is running. It should be remembered that slip clutches are provided as a means of protection against overloads. They should be adjusted, therefore, with just the amount of tension needed to drive the load that is ordinarily expected.

Excessive slipping is bad on the clutch and reduces effectiveness. It can be avoided by tightening the clutch. Slip clutches require lubrication to insure free operation.

Combines are operated either through a power take-off on the tractor or by a separate engine mounted on the machine and drawn by a tractor. For either kind, the power unit should be checked for good operating conditions so that adequate power will be available to operate the working parts of the combine.

In the maintenance and repair of a combine, safety shields are sometimes not replaced after adjustments and repairs have been completed. This is a mistake and should be avoided. All safety shields should be in place when the machine is put into operation. For best results in running a machine as complex as a combine, and especially when such a machine is used only a few weeks during the year, it is always good practice to study and follow the instructions supplied by the manufacturer.

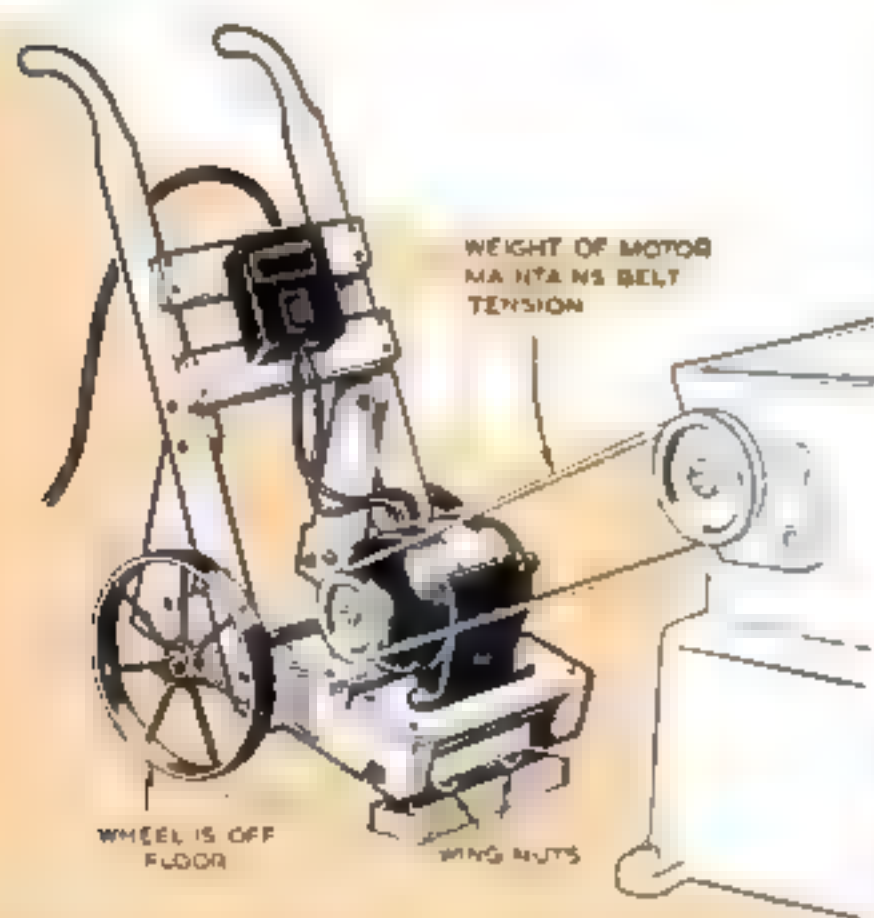
Easily Built Hand Truck Moves Farm Motor from Job to Job

WHEN one motor must do the work of several, it should have sufficient power for the heaviest task. On farms, the Rural Electrification Administration advises, a 5-hp., single-phase, 1,750-r.p.m. motor is economical on any job requiring from $\frac{1}{2}$ to 5 hp. The REA designed the hand truck below to facilitate transporting such a motor from job to job.

This truck is built mostly of wood, two-

by-fours being used for the low side rails, 1" by 6" stock for the motor mount, and 1" by 4" pieces for the handle ties and braces. The handles may be plow handles, and the wheels may be either wood or metal.

A yoke of $\frac{3}{4}$ " by 2" by 20" bar iron bent into a U with a 12" base pivots on a $\frac{3}{4}$ " pipe at the front. It slips over two bolts permanently inserted in the floor near each machine to hold the motor in position.



AA Guns Think for Themselves (Continued from page 119)

Guns, cartridges, and projectiles were getting bigger for three reasons: the projectile had to go higher to reach its target, its area of burst had to be expanded, and its line of flight had to be put under better control.

So much for the guns and ammunition. Something else had been happening behind the guarded doors of armament laboratories.

The artilleryman firing on stationary ground targets has to consider two elementary factors: distance and direction. He must also reckon with the muzzle velocity of his shell, the direction and velocity of the wind, and the density of the air. To simplify his job he uses ballistic tables to establish direction and elevation and compensate for the other variables.

The antiaircraft artilleryman has to deal with three elementary factors: distance, direction, and—perhaps most important of all—speed. Speed is measured in fractions of a second. A gun crew firing at a bomber flying 300 miles an hour at an altitude of six miles must "lead" the target by $1\frac{1}{8}$ miles to hit it, because it takes 14 seconds for the projectile to attain that height. In 14 seconds that bomber travels 5,160 feet. Speed alone catapults the problem of aiming the gun into the realm of higher mathematics.

But the complications have only begun. In addition to muzzle velocity, density of the air, and direction and velocity of the wind, the AA gunner must allow for the course his target is taking, the number of seconds his projectile will be in flight, the effects of gravity and "drift," and the parallax, or angular and linear displacement of his gun from the point at which his firing data is compiled. "Drift" means straying from a true course. It is caused by the spin imparted to a projectile by the tube's rifling, just as a baseball curves in flight.

It is understandable that the rudimentary AA gun of World War I had to be fired 17,000 times to hit an airplane.

As plane performance burgeoned in the interval between wars, better fire-control apparatus became imperative. In World War I the French devised two crude instruments called "correctors" to determine azimuth (or traverse) and the probable time of flight of the projectile so that the fuse could be cut properly. They also devised an ingenious height finder that remains fundamentally unchanged to this day.

Our Army knew that here was something

that required more than cursory study. In 1925 the Chief of Ordnance called in Maj. Wm. P. Wilson, an ordnance expert of extraordinary mechanical ability.

"Develop something new in antiaircraft fire control," Major Wilson was told. He went to work at the Frankford arsenal. What he finally produced was known as the "Wilson Director." For the first time, a piece of AA fire-control apparatus was fitted with precisely cut metal cams in various shapes. In part, anyway, this calculating device, working on principles employed in office computing machines, solved the problems posed for a gunner trying to hit an elusive target moving in three dimensions.

In 1926, Britain's Vickers-Armstrong produced a better director. It computed range, time of flight, speed of the target, azimuth, and angle of sight. Better yet, it introduced a mechanism to establish a rate of change in the range.

To simplify the problem of rate of change, imagine a tennis player swinging his racket to meet a sharply "cut" ball. The ball curves and drops. As it flies over the net it loses velocity and curves in both horizontal and vertical planes. Long practice enables the receiving player to accommodate his stroke to the rate of change.

When AA artillerymen knew the rate of change, it was easier to compute the distance by which a gun had to lead a target moving obliquely across the area of fire. Vickers used cams and gears, too, but there was too much "dead time" between director and gun. Something had to be done. Vickers turned over their gadget to America's Sperry Gyroscope Company to incorporate in it a system for transmitting data to the gun.

Sperry did it. What came out of the director was given instantaneously to the gun crew by synchronous motors. A synchronous motor is the same thing as is used on teletype machines to duplicate electrical impulses on identical equipment separated by one mile or a thousand miles.

But Sperry went farther. It built a better director of its own. With cams, disks, slides and radius arms, it solved instantaneously and continuously problems that would have required hours of figuring in trigonometry and geometry by the pencil-and-paper method. The Vickers dials with their pointers or "bugs" were mounted on the gun proper to duplicate the information at the director.

The thing wasn't perfect. The director could add, subtract, divide, multiply, differ-

entiate and integrate. It could "consult" ballistic tables. But delivering its results to the guns in readable form was another matter. The bugs oscillated, and the gun aimers and fuse setters had to strike averages.

Worse, the contrivance was a marvel of immobility. It weighed 3,300 pounds. The director operators had trouble, moreover, in establishing the rate of change in range and altitude.

The Army asked if something couldn't be done about that. Something was. By 1934 Sperry had installed in its director automatic accommodation to changes in range and altitude rates, so that an operator had only to turn a knob with his fingers to make the bugs match. The refurbished instrument became known as the M-4 AA director, and the Army ordered it practically off the drawing board.

Today the same director, modified and lightened to the point where eight men can carry it, is in the service of the U. S., British, and Russian armies. It is the only director that is toted up to within hearing distance of front-line gunfire. Used mostly on the 90-mm. gun, it also can be attached to 75's, three-inchers and 105's, and the new AA 120. It can be employed against ground as well as air targets. For all its 12,000 parts, a person with a high-school education can be taught in a matter of weeks to service it in the field.

Data flows into it and the answers flow out. To learn how high to aim the gun, in which direction to point it, and what fuse setting to put on the projectile, the five men who operate it feed it three different elements: the angular position of the target in a horizontal plane; the angular position of the target in a vertical plane; the speed of the target.

The job of shoveling in facts to get answers isn't difficult. Tracker operators deftly turning cranks merely keep the target on telescope cross-hairs. The director does the rest. Fed into it too are the altitude of the target, obtained from the altitude-finder, the effects of gravity, wind, and drift on the projectile's flight, parallax, and fuse dead time.

In 1940 engineers of the Bell Telephone Laboratories began work on an electronic director. The first one was delivered to the Army for test a week before Pearl Harbor. It proved to be just a shade more accurate than the mechanical director. It was a little faster. It compensated for more factors that might cause a projectile to miss its target.

In addition to the ever-changing variables progressively fed into its nest of wires, it provided for dial settings on two other "fixed variables" to be taken into account in the data delivered to the gun. These were the

Velocity of the projectile and the air density.

The electronic director, weighing about a ton, is less mobile than Sperry's. That its 3,300 parts include some telephonic devices was hinted at last November by Dr. Harvey Fletcher, the Laboratories' director of physical research, when he said many of them "can be incorporated into various products and may be adapted to the improvement of telephone switching systems."

The director's work was not done when it had begun delivering perfect firing data to a fuse cutter and the azimuth and elevation operators riding the loading platform of a gun. It could be made to control the gun remotely, too.

A workable remote-control system was installed on the M-1 90 mm., immediate forebear of the current M-2, in 1940. Also a Sperry development employed as well on the 120-mm. gun, it utilizes some electronics but depends mostly on hydraulics. On the M-2, a pair of hydraulic motors weighing only six pounds each will traverse five tons of cradle, barrel, and appurtenances through 360 degrees in 18 seconds. They will elevate a perfectly equilibrated barrel from five degrees below horizontal to 85 degrees above in six seconds.

Set for remote control, a gun is aimed, its projectile fused, and its cartridge and projectile rammed home by a director in a camouflaged dugout hundreds of feet away. The control is not wholly remote. The gun crew has three functions to perform: to provide the gun with ammunition, to pull a lever to start the cycle of fusing, ramming, and closing the breechblock, and to fire.

As a capstone to the scientific placement of antiaircraft projectiles exactly where they are needed, American ingenuity contrived a fuse to detonate the powder charge at any instant that the director dictates. The Army is willing to say only that its mechanism is as fine as that of a watch. That's the tip-off: it works with gears instead of the customary powder train.

Our Army can boast that it has the world's best AA guns. The German 88 mm. is a superior gun—by yesteryear's standards. Ballistically it probably compares favorably with the American 90. Its firing data is transmitted electrically from director to gun battery. But there it falters: the guns are traversed and elevated manually. That makes for misses. Japanese weapons are too obsolete for consideration. The Nips use a 120-mm. dual-purpose naval gun for AA fire, but its results are not so hot.

On the record, antiaircraft gun crews still have to fight the problem of spotting and tracking targets under conditions of poor visibility. Off the record, American ingenuity has found an answer to that, too.

Electronics in Postwar Industry *(Continued from page 132)*

under pressure. The material is fed through a pair of rollers connected to a radio-frequency generator. Since the rollers are merely terminals and do not get hot themselves, the material has no tendency to stick to them and is readily welded into an air- and watertight bond.

In the development of mercury-arc and other electronic rectifiers for large-scale conversion of AC into DC, we see one of those long-term swings in technological history that color the lives of millions.

Around 1880, Thomas A. Edison created the electric-power industry from the theoretical materials of Faraday and the other pioneers. DC was his baby and he could never see anything else. But for some decades thereafter, the development of AC technique, associated with Westinghouse, Stanley, Tesla, Steinmetz, and other great names, was the principal feature of electrical engineering. Although DC remained important in electric traction, in communication, on ships, and later for ignition and lighting in automobiles and airplanes, in this period it was definitely in second place.

Now we are witnessing a veritable renaissance of DC. One reason for this is the superiority of the DC motor where flexible speed control is needed. A much bigger influence, however, is the rise of the electrochemical industry, in which DC is needed for the electrolytic production of magnesium, aluminum, copper, and other light and heavy metals. Since power distribution remains an AC province, this calls for increasing numbers and higher powers of electronic rectifiers of the ignitron type. Rotary converters could be used, but rotating machinery has its disadvantages, especially at high voltages. Tubes are less liable to become damaged from overloads, and are better adapted to handle varying power requirements.

The availability of convenient and efficient rectifiers, in turn, encourages industrialists to use DC equipment for still other purposes. So DC and electronics, in partnership, are going places—and the technological irony of it is that all rectifiers derive originally from the "Edison effect" of electronic emission from lamp filaments, which dates back to 1883. AC won out over Edison, but now, to an increasing extent, we are converting AC back to DC, using another of his nuclear ideas.

Even in the field of long-distance power transmission, in which AC has reigned unchallenged for half a century, it may have to move over and make room for DC. Among

other engineer-prophets, J. D. Ross, the public-power magnate of the Northwest, foresaw vast power transmissions over thousands, not hundreds, of miles—from generating sites near deposits of cheap coal to the great industrial centers. Ross talked of blocks of a million kilowatts to be transmitted from the lignite beds of the Northwest to Chicago and New York. But not by AC.

For one thing, the potentials required would be of a half million volts and up. With AC this would entail peak voltages 1.41 times as great, which at a given point would become impossible to handle. A DC voltage is always the same and, since it has no peak value, is less liable to trouble from corona and flash-back. DC is also free from inductive and capacitive losses.

Alternating current would remain in the picture for generation and voltage transformation, but once the voltage was stepped up, grid-controlled mercury-arc rectifiers or equivalent electronic means would convert it to DC for transmission. At the other end, the power would again be converted to AC, stepped down for local distribution, and consumed either as AC or, after another rectifier stage, as DC.

The first modern factories generated water and, later, steam power in large blocks and distributed it mechanically to the machines through a mass of ceiling drive shafts, pulleys, and belts in which the greater part of the power was lost. The only method of speed control the individual operator had was to change pulley ratios. He stopped his machine by letting the belt run free, or by means of a clutch. Individual electric-motor drive, which began to come into use in American factories in the late 1880's, gave the operator much more accurate and flexible control. But it still involved human reactions and judgment, and it was necessarily discontinuous. Something happened and somebody did something and the machine responded, early or late, rightly or wrongly, depending on the skill of the operator and the inertia of the intervening mechanism.

Engineers and industrialists realized that the ideal method in mass production would be to let the material being worked make its own predetermined and continuous adjustments of the driving mechanism. This obviously required some form of feedback by which the material could talk back to the machine. An example is seen in Fig. 1 on page 131, where a loop in a sheet or wire strip that is being fabricated regulates, through mechanical or electrical linkage,

the speed of the driving machine in proportion to the increasing diameter of the material as it winds up on a reel.

But what was the feedback linkage to be? If, in order to control the power source, it had to handle considerable amounts of power itself, the inertia of the parts would slow down the response and make the mechanism less effective. Obviously, what was needed was an amplifier. The electronic engineers furnished the solution in the form of a system of vacuum tubes and associated circuits which, given a small stimulus, would react in a big way—silently, reliably, and in practically no time at all.

Fig. 2 shows one form of electronic motor control. A DC motor has its field and armature supplied from an AC source through an adjustable voltage rectifier using thyatron tubes. When the loop becomes too long, the reactor core enters the coil, altering the phase relations of the grid and plate voltages in the thyatron and causing the motor to speed up. A short loop withdraws the core and slows down the motor. Instead of a reactor, a photoelectric system may be employed, as in Fig. 3, where the loop varies the amount of light reaching the photocell and regulates the speed of the motor accordingly.

An outstanding advantage of this type of electronic motor control is that the tubes act as both rectifiers and regulators, making it possible to use DC motors on existing AC power lines. The AC motor is essentially a constant-speed device, since its speed bears a fixed relation to the frequency of the current. Manufacturing processes often require a variable-speed drive. The DC motor fills this requirement perfectly. It is possible not only to vary speed as required by the manufacturing process, but to control acceleration, deceleration, and even direction of rotation. The electronic control will start the motor, bring it up to a preset speed, change the speed, brake and stop the motor, then reverse it. All the operator has to do is put the material into the machine, press a button, and take the finished work out. In some cases, all he has to do is press the button.

Devices of this kind have been in use for about 10 years. So far, electronic motor control has been applied only to motors of relatively small horsepower, particularly in the machine-tool industry, but with larger tubes there is no reason why it cannot be used to control larger motors.

Electronic motor control belongs to a class of devices capable of doing something electronically that otherwise would have to be done—usually not so well—by human effort. The converse of this is when something is kept constant under changing conditions,

like the output voltage of an alternator under varying load. The same thyatrons that vary motor speed can be used to vary the field excitation of the alternator, raising and lowering it in proportion to the shifting load more accurately than a human operator could do it, and keeping the AC line voltage constant to within a fraction of a volt.

Then there is a multitude of electronic detecting, counting, sorting, and inspecting devices. The inertia of electrons is negligible, and photoelectric relays are now made to operate reliably 1,000 times a minute. Some electronic counting systems will respond to half a million counts a minute. From counting it is only a step to sorting. If defective rivets have a different color from sound ones, the photocell will differentiate between them and, through a relay and motor system, knock the defective rivets to one side as they pass down a chute. Differences in magnetic or acoustic behavior can likewise be used to separate the sheep from the goats. Phototubes will detect irregularities in the width, thickness, or hardness of sheet metal, or pinholes that cannot be caught by the human eye.

Finally, electronic devices can be used not only to replace the human senses and muscles, but to veto human actions. The operator of a machine gets his hand too near the cutting tool. A light beam is intercepted and the machine stops before anything can happen. Industrial accidents are one of our chief enemies. The National Safety Council reports that from the time of Pearl Harbor to the spring of this year, industrial accidents killed 102,000 war workers, permanently disabled 350,000 more, and injured no less than 9,500,000. Anything that electronics can do to reduce these tragic totals will be welcome indeed.

Electronics will certainly play a large part in the new world and solve many industrial problems, but it may create new economic and political ones. Electronic devices in industry are, in great part, labor-displacing devices.

True, postwar electronics will create jobs in other fields, as in television, and perhaps by reducing manufacturing costs of many articles. But we have no guarantee that on net balance it will increase employment. If, then, we want progressive factories, we shall also need progressive thought about what we are going to do with those factories. Such questions will inevitably arise, and no electronic machine will provide the answers.

The fourth and concluding article of this series, on electronics and public health, will appear in the October issue.

fighters were used for skip bombing the first time, they surprised the enemy; but it wasn't long before they had to depend on firepower and tactics to succeed in the job. Fortunately, they had both. The P-38, for example, can come in ahead of its own roar, toss its bombs, and be away before the enemy knows what has happened. It can, if advisable, carry two 1,000-pound bombs.

The utility pilots work all kinds of variations on the skip-bombing technique. With a P-38, for instance, they have hooked one auxiliary fuel tank under one wing, a 1,000-pound bomb under the other wing, and gone out well beyond the expected range to deliver the goods. At times they have put the finishing touches to an enemy ship by dropping a partially full fuel tank on its deck, bomblike, and then setting fire to it with a burst of incendiaries from their guns. In one engagement a group of utility P-38's on a skip-bombing mission in the Pacific ran into so many ships that they used all their bombs and still hadn't got around to one destroyer. So they took turns in strafing runs and sank that destroyer with cannon fire from their nose guns.

That's the ace-in-the-hole a utility plane's pilot usually has—he isn't confined to one type of action. Even when he has spray tanks under his wings and is out on a smoke mission, he can do a magnificent strafing job if he thinks that will help clean out the gun pits or immobilize an enemy airfield. If he is on a skip-bombing mission and finds that conditions demand glide bombing instead, he can deliver the goods in that manner. The P-38 is not ideal as a glide bomber, even though the pull-out in such an attack is usually at about 2,500 feet. But in some areas the boys have throttled down their Lightnings and lobbed the bombs in from pretty well up there. And always they come out of the clinches fighting. When you have a mile a minute of climb in your ship, as the P-38 pilot has, you can make things hot for almost any opposition.

That was one lesson the Germans had to learn over Europe: that not all the Allied ships which bombed the invasion coast were medium bombers with more or less limited speed, climb, and altitude. When our utility fighters went in with bomb loads and were attacked by Messerschmitts, they simply dropped their bombs and went to work. The P-38's could go right up above 40,000 feet, along with the ME's, and their speed was well in excess of 400 miles an hour after they got there. The Germans found they hadn't

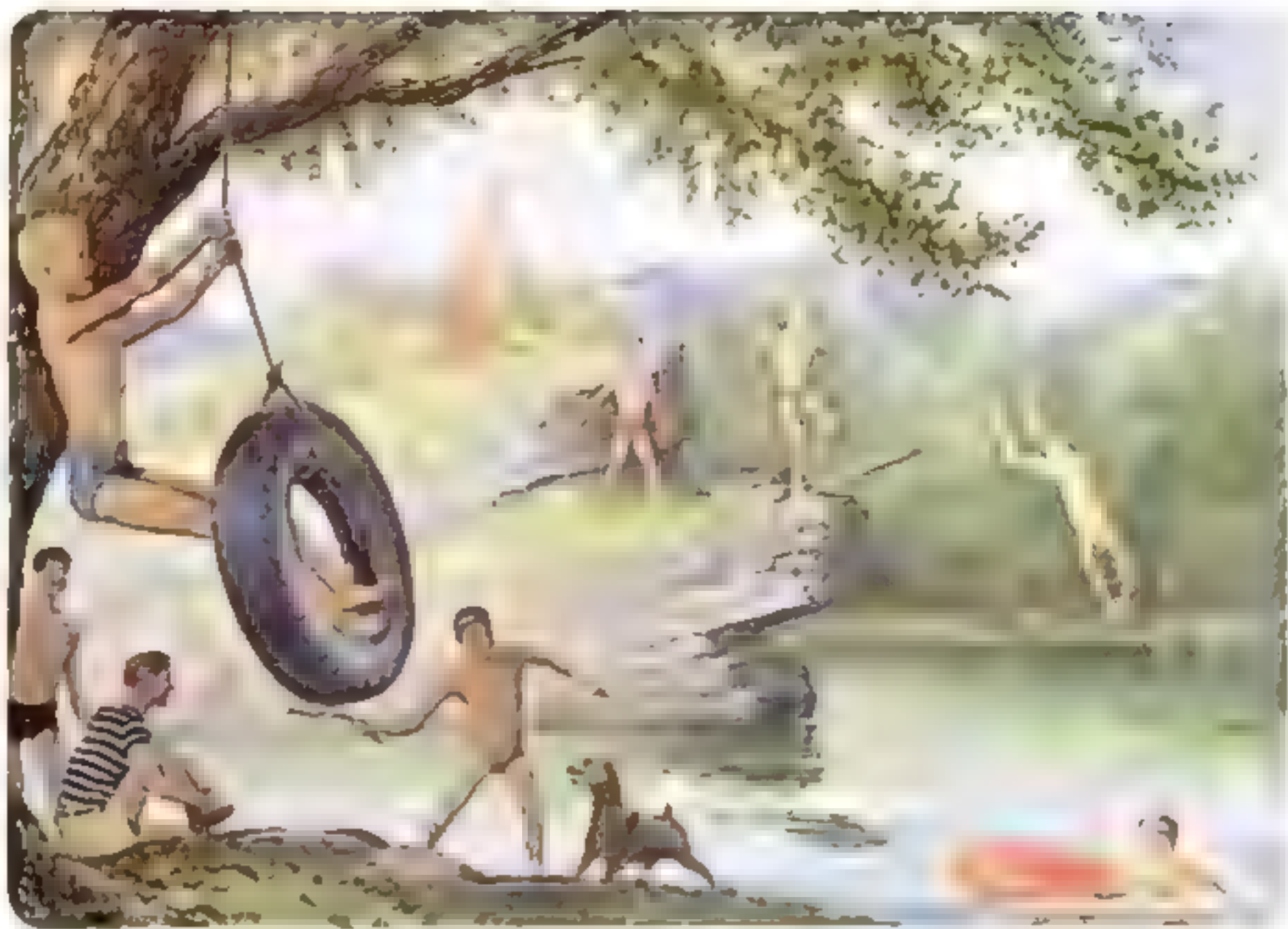
jumped any bunch of pigeons. Thereafter they were considerably more wary about leaping to the attack the instant a low-level bombing mission hove into sight.

Any utility plane should be of use in reconnaissance, if it is a really capable all-around ship. Here the P-38 showed its capacity soon after it got to the fighting fronts. The ideal recon ship must be able to take care of itself without any armament at all; it must go places in a hurry, work at both minimum and maximum altitudes, and have a considerable range. On all counts, the Lightning qualified. Replace its guns with cameras and you reduce its weight. Cover the gun ports, thus smoothing out its nose contours, and you could add 40 or 50 miles an hour to its speed. No structural changes were necessary to mount the cameras.

So the work horse became a race horse, and the recon pilots began running the gantlet. With continuous-strip cameras (P.S.M., July '44, p. 94) they roared over the beachheads and the immediate objectives, outracing enemy interceptors and dodging flak. With tri-metrogon cameras (P.S.M., Jan. '44, p. 68) they mapped more remote areas, going a long way to get their pictures. With long-focal-length cameras they hovered over enemy strong points at as much as 36,000 feet and brought back invaluable information.

The Japs tried to stop them, but the P-38's simply ran away from the fastest ships sent up against them. Now and then a recon pilot got peevish and refused to run, as Alex Guerry did when four Jap Zero float planes jumped him. They were as pesky as gnats, until Guerry turned on them. He literally drove them out of the air, forcing all four down on the water. He administered the final humiliation by buzzing them so close that his prop wash capsized one and left its pilot floundering in the blue Pacific. Then Guerry, wishing he had just one gun with which to do a real job of it, went home and developed his pictures.

The utility plane has proved its worth a hundred times over. It grew out of necessity, and it remained because it filled a definite need. The men who fight the battles wouldn't give it up, and they are continually finding new uses for it. They, too, are specialists—up to a certain point. But beyond that point they are jacks-of-all-trades, using every weapon at hand. More often than not, the weapon they reach for at that stage is the utility plane—the ship that can do almost anything.



Remember when . . . *your good tires wound up at the old swimmin' hole?*

THAT OLD CASING made a dandy swing, so what if it *did* have a few thousand miles left in it?

The tubes that bobbed so merrily in the water could still hold air. But that didn't matter, either! For in those days, rubber was plentiful.

What wouldn't a lot of us give for those same tires and tubes today! Many of them, no doubt, were almost as good as the ones on which we'll probably have to ride for many long months to come.

The rubber crisis is not over—and until it is over it is squarely up to you to get every possible mile from your present tires.

Rule No. 1: Keep air pressure up to 32 and speed down to 35. Rule No. 2: Have your tires recapped as soon as they're smooth. (Recapping is not rationed.) The rest is

just careful driving and watchful attention.

Making those tires of yours last is more than just a matter of keeping your own car in shape for your own use. It's joining up with other good Americans from coast to coast to help win the great Battle of Rubber—and keep America's wartime transportation rolling until the war is won.

★ ★ ★

Whenever you see a "Seiberling Tire" sign, you can be sure that it marks the establishment of an **INDEPENDENT** business man—a man who has had the courage and initiative to go into business "on his own"—and thus **CREATE JOBS FOR OTHERS**. He could do this because, here in America, we believe in "Free Enterprise"; we believe that the greatness of this country in the future, as in the past, must depend in large measure upon the opportunities it offers for the independent business man to grow and prosper. Seiberling Tires always have been and will continue to be sold by **INDEPENDENT** dealers only!

SEIBERLING

Experts in Rubber



War-time manufacturers of Bullet-Sealed Tubes and Military Tires for our armed forces • Bullet-Sealing Gasoline Tanks • Rubber Floats, Boats and Pontons • Rubber Parts for Gas Masks, Airplanes and Tanks • Also makers of Tires and Tubes for passenger cars and trucks • Sealed Air Tubes • Rubber Heels, Soles and Mechanical Goods.



This measuring glass contains slightly over half a pint of gasoline. Mixed with about 75 cubic feet of air and metered into a Cyclone 9 engine, this cupful of fuel, in contributing its share of the total power, will produce one horsepower for one hour.

No other type of gasoline engine does as much work on this amount of fuel; your car would require about 20% more gasoline to produce one horsepower for one hour. In engineering terms, the Cyclone's cruising consumption is at the rate of 0.41 pounds of fuel per horsepower per hour. Cyclones have operated on extended flights at cruising power on 0.39 pounds per horsepower hour — even less under careful control — but 0.41 represents

the average for millions of hours of routine operation.

Minimum fuel consumption is determined by the engine design, depending on such factors as the compression ratio, the induction system, and the contour, size, and cooling of the combustion chamber. The carburetor's function is to provide the most desirable mixture for its engine under various conditions, but it cannot determine fuel economy because an engine will not run leaner at a given power than its design permits.

On a ten-hour flight in a four-engined airplane the seemingly fractional difference in consumption between the Cyclone 9's average lean rate of 0.41 lbs. and the general average rate of 0.45 lbs. can amount to a saving of 160 gallons. The fuel saved with Cyclones represents almost 1,000 pounds of extra cargo or five additional passengers. In a year, this difference can mean a saving of 50,000 gallons on a four-engined plane — fuel approximately equal in cost to an engine.

Wright Cyclones pay their way.



Cyclones and Whirlwinds - Light - Compact - Powerful **WRIGHT** *Aircraft Engines*



This measuring glass contains slightly over half a pint of gasoline. Mixed with about 75 cubic feet of air and metered into a Cyclone 9 engine, this cupful of fuel, in contributing its share of the total power, will produce one horsepower for one hour.

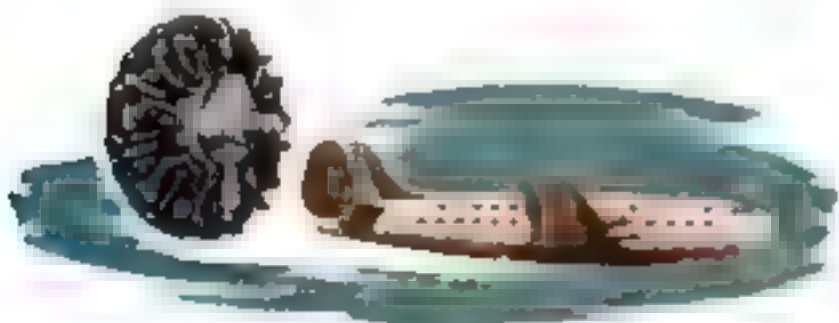
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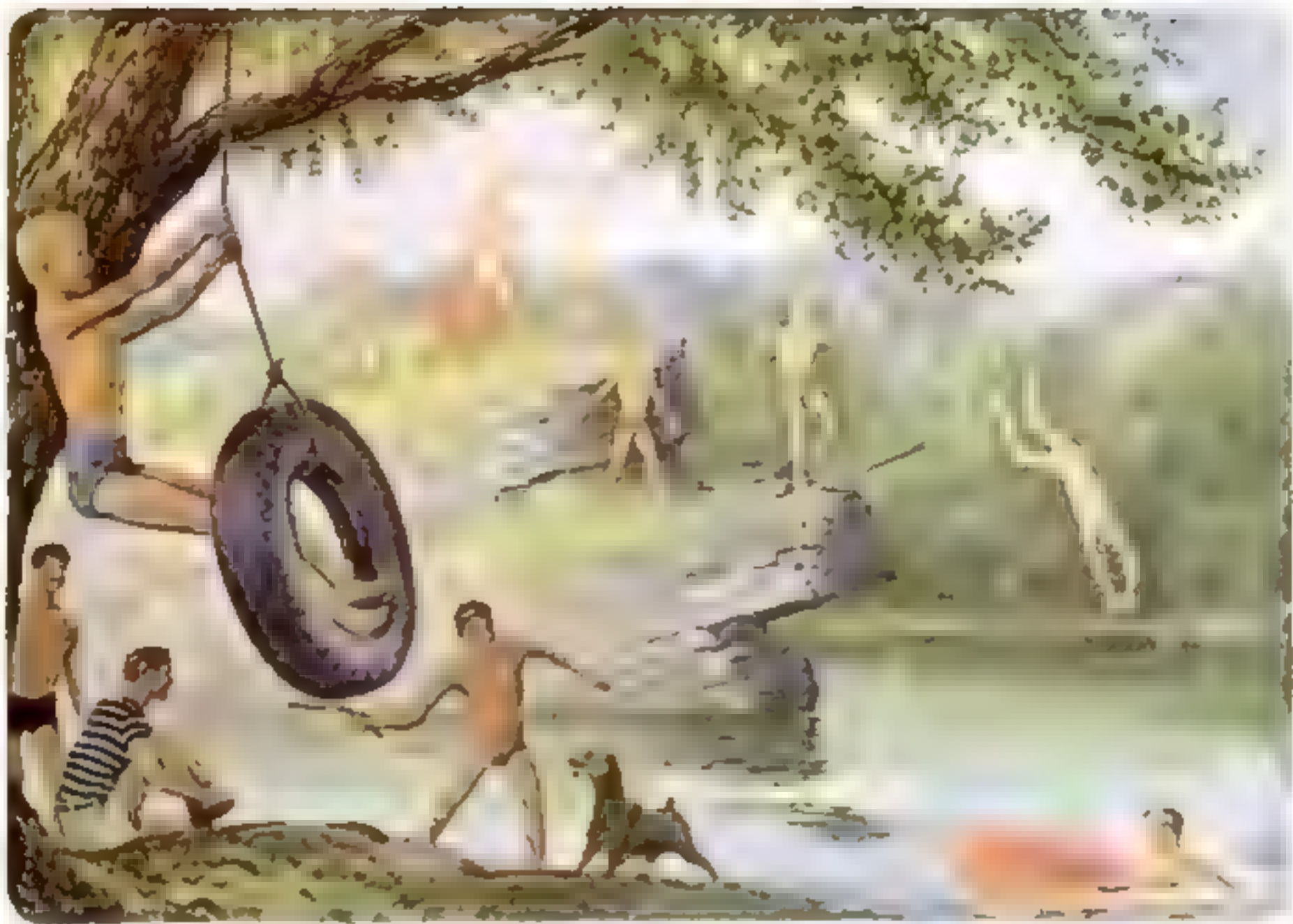
Wright Cyclones pay their way.



Cyclones and Whirlwinds - Light - Compact - Powerful

WRIGHT

Aircraft Engines



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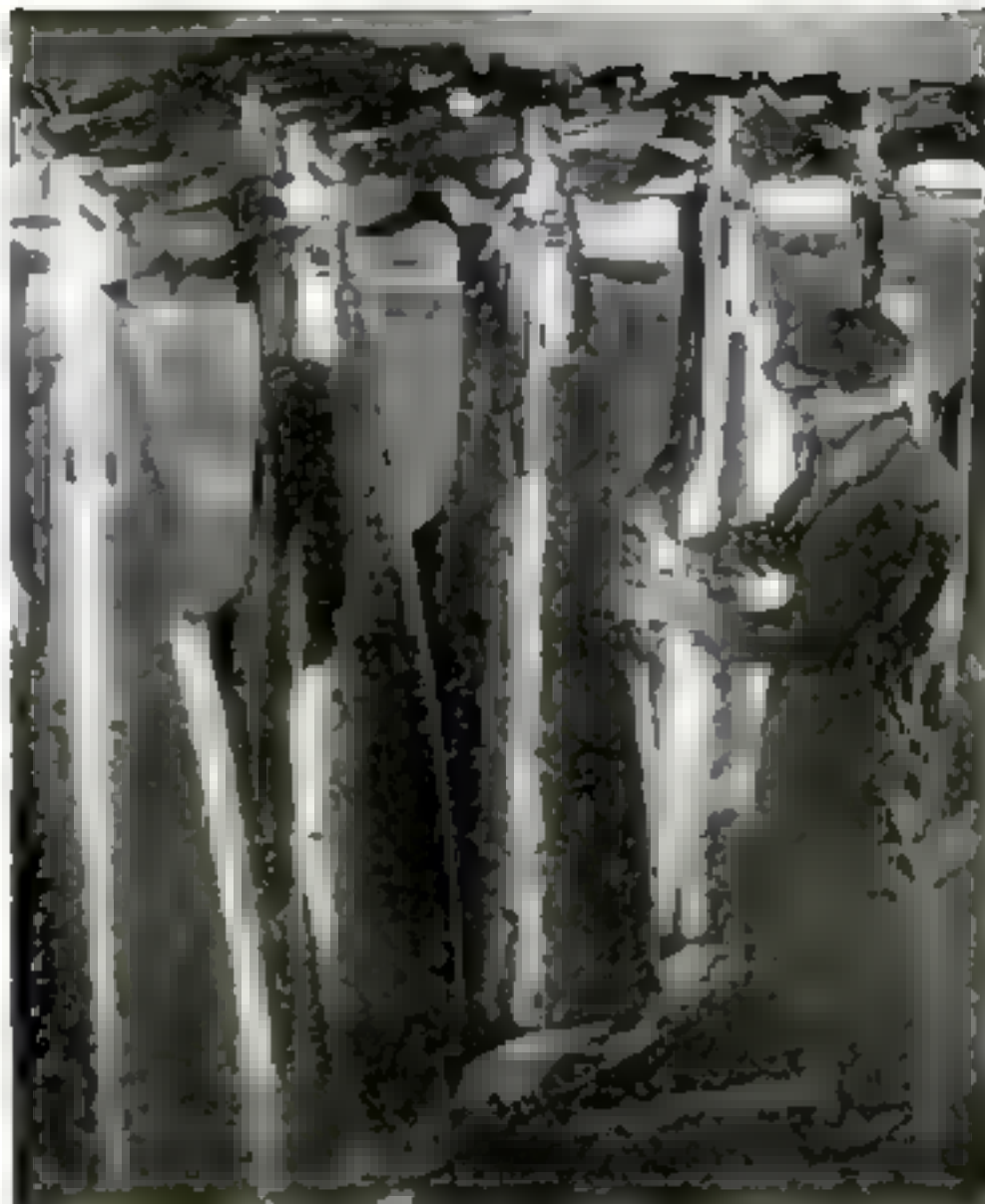
SEIBERLING *Experts in Rubber*



Wartime manufacturers of Bullet-Sealed Tubes and Military Tires for our armed forces • Bullet-Sealing Gasoline Tanks • Rubber Floats, Boats and Pontons • Rubber Parts for Gas Masks, Airplanes and Tanks. Also makers of Tires and Tubes for passenger cars and trucks • Sealed Air Tubes • Rubber Heels, Soles and Mechanical Goods.

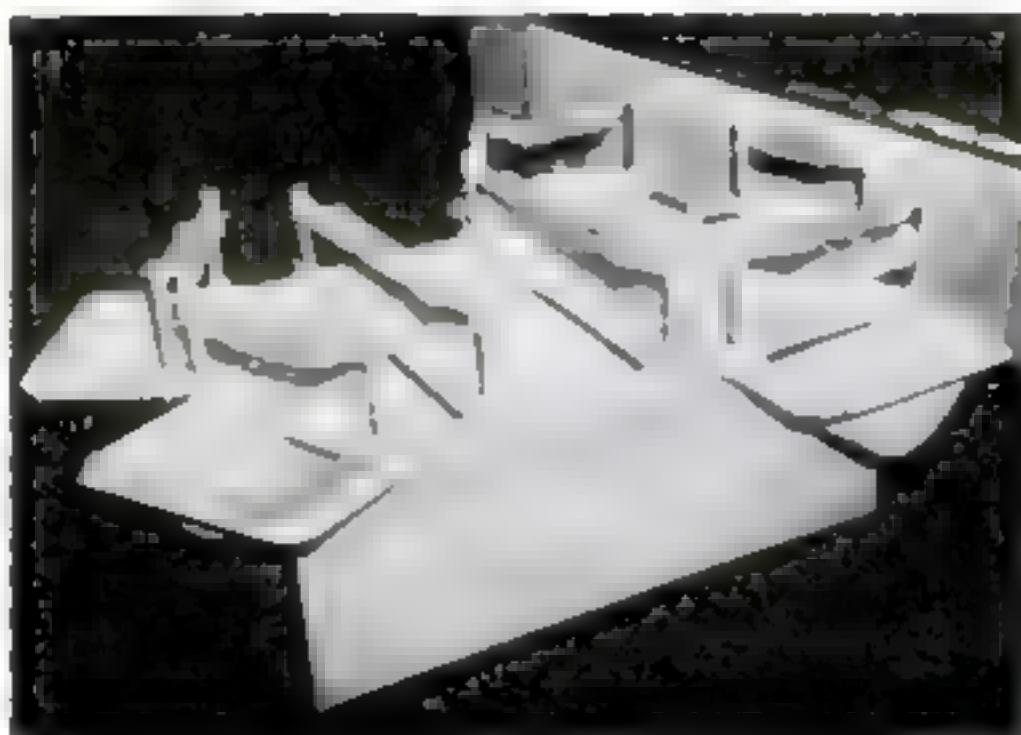
TORPEDO TAIL ASSEMBLIES, shown stored in a Canadian naval dockyard, need an occasional coat of grease as a guard against rust. Their condition must be carefully maintained, for the mechanism in the tail sets the depth of the torpedo's course. In such storage centers and naval repair yards, the Canadians are giving prompt and efficient attention to the overhaul of battered war and cargo vessels and the repair of heavy ordnance and other matériel.

Hundreds of trades and special skills are brought to bear on the many problems of construction, repair, and refurbishing. Prominently displayed in one of the war plants is the sign "When Work Relaxes It Helps the Axis," and it is taken in dead earnest by every workman, whether he is plugging a hole in a torpedoed ship, truing up a big gun, welding an engine crankshaft, splicing hawsers in an old sail loft, or making adjustments in marine binoculars.



TO HELP SMOKE OUT the Axis, these young Canadian women are turning out two-inch tank smoke-bomb throwers in a plant that formerly made equipment for elevators. Most of the 100 women in the plant came to their work without ever having seen a lathe, drill, milling machine, or any other machine used in war plants. The girl seen at the left is checking junction nuts that open the bomb-thrower for loading; the one at the center is gauging barrels; and the one at the right is inspecting the completed thrower.

FOR EASIER ACCESS to the body of a patient suffering from burns or infected wounds, Dr. Neal Owens, professor of clinical surgery in the Tulane University School of Medicine, has developed a new surgical tub. It is shaped to accommodate a person lying on his back with arms spread perpendicular to his body and legs slightly apart. The patient is suspended on sterile canvas straps to permit thorough cleansing of the whole body and the application of dressings with greatly lessened danger of infection and contamination. Small metal supports pointing upward from the rim secure the straps.





Fluid Power

MAKES MOLECULES BOUNCE!

In synthetic rubber plants, Fluid Power helps pry the molecules apart and squeeze them into new combinations. Liquids and gases are measured, mixed and transformed to meet the exacting standards of chemical formulas.

Fluid Power is transmitted through tubes. It helps to drive, control and regulate... all the way through from the raw ingredients to the bouncing tire.

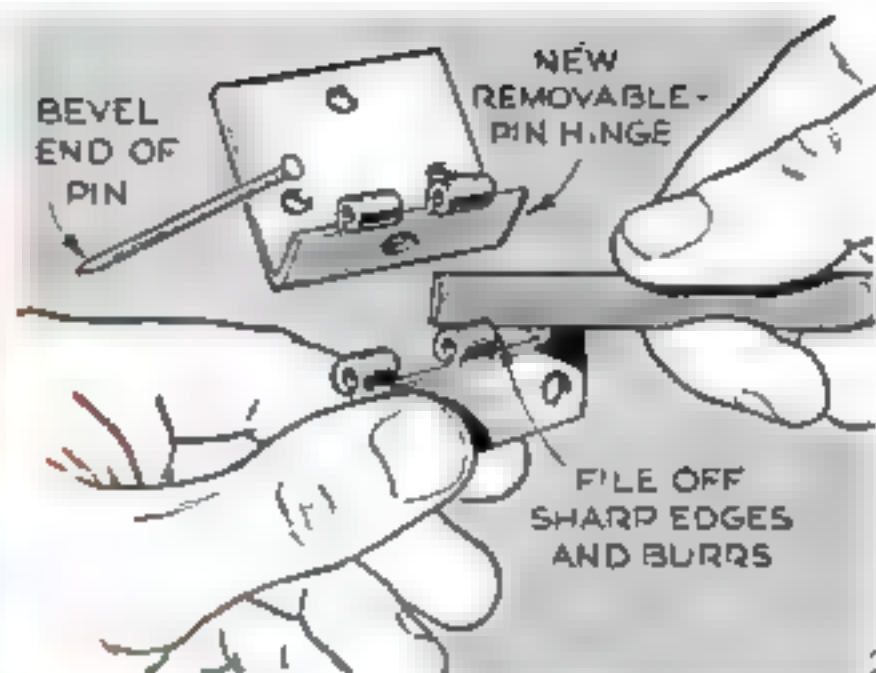
Fluid Power is simple, dependable. And that's an essential in the complex operations of rubber and chemical plants and modern oil refineries. Whether the job calls for precision timing or powerful, remote control, Fluid Power does it efficiently—and without coddling!

Where and how can Fluid Power be put to work for you? The applications are limitless. A Parker engineer will be glad to discuss your problem with you.

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FLUID POWER ENGINEERING



Fitting Removable-Pin Hinges

WHEN hanging a door that has removable-pin hinges, file the sharp edges and burrs off the hinges, as shown above, before screwing them in place. They will then come apart and slide together without sticking or catching. Then bevel the ends of the hinge pins and lubricate them with a drop of oil so they will not catch in the joints when they are inserted.—J. M.

How to Saw Used Lumber



YOUR saw blade receives more wear at the center than at the ends. In order to equalize this wear, do all dangerous jobs, such as cutting through a board that you suspect contains an embedded nail, with the tip or the heel of the blade. The metal in these parts can better be spared if you strike a nail and have to re-form the teeth.—J. M.

Protecting Broken Fingernails

TO PROTECT the rough edges of a broken fingernail, apply several coats of clear nail polish to it. A nail so treated is easier to keep clean than one guarded by adhesive tape.—CHARLES E. MARTIN.

INSPECTION PROBLEMS?

Here's how Controlled Lighting saves time on tough inspection jobs



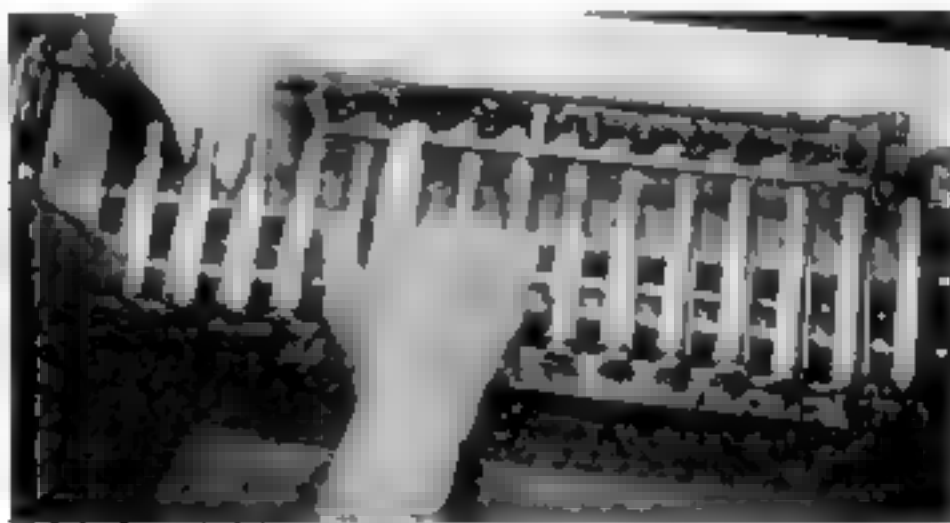
G-E REFLECTOR LAMP

REFLECTING MIRROR

To look inside a 75 mm. shell was difficult...until G-E lighting engineers helped work out a faster, more accurate inspection method. A standard G-E reflector lamp with a mirror arrangement "turns shells inside out"—makes sure there's no grease, dirt or pitting. It's a typical example of inspection methods that use controlled lighting...and it's another instance where G-E engineers have helped to gain faster, better inspection methods.



1 Brightness contrast patterns are useful for the inspection of chatter in polished metallic surfaces. Reflections reveal defects of unevenness and other irregularities.



2 An inspection unit developed specifically for cartridge case inspection. It makes use of reflected light from mirrors, showing the interior and primer cup end of the cases.

In these special applications—or in standard installations—be sure you get the utmost in lighting quality. Look for the famous G-E monogram on all the bulbs you buy.

Send For New G-E Booklet That Gives The Facts On Lighting For Inspection. Write to General Electric Co., Div. 166-PS-1, Nela Park, Cleveland 12, Ohio.



*"TO MAKE G-E LAMPS
STAY BRIGHTER LONGER"
The Constant Aim of G-E LAMP RESEARCH*



KEEP BUYING WAR BONDS—KEEP THE WAR BONDS YOU BUY

G-E MAZDA LAMPS

GENERAL ELECTRIC

Hear the General Electric radio programs: "The G-E All-Girl Orchestra," Sunday 10 p. m. EWT, NBC;
"The World Today" news every weekday, 6.45 p. m. EWT, CBS.

SCREWBALL IDEAS ON BATTERY CARE



Quagmire Thistledown puts his hope in dope. Somebody sold him a magic fluid that's supposed to put new life in tired batteries. Sorry, Quagmire, but it won't work. Throw away that magic "soup" and follow suggestions below:

THE WISE WAY IS PERIODIC RECHARGES!

DON'T wait until your battery goes dead. If your driving is restricted by rationing, drive in to your Exide Dealer for an occasional **FREE CHECK UP!** When necessary, he'll advise a periodic recharge. At little cost, periodic recharges will keep your battery strong and postpone the day when you'll need a new one. When you *must* buy, get a dependable, long-lasting Exide. Buy to Last—Save to Win.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

EXIDES ARE USED IN MORE THAN 100
APPLICATIONS BY OUR ARMED FORCES



- 1 Don't buy anything you can do without.
 - 2 When you **MUST** buy, insist on dependable, long-lasting merchandise.
 - 3 Take care of the things you have. *Make them last!*
- These conservation rules save materials for war production, help curb inflation, give you more money to invest in War Bonds.



FIRE ENGINE - new job for a jeep!

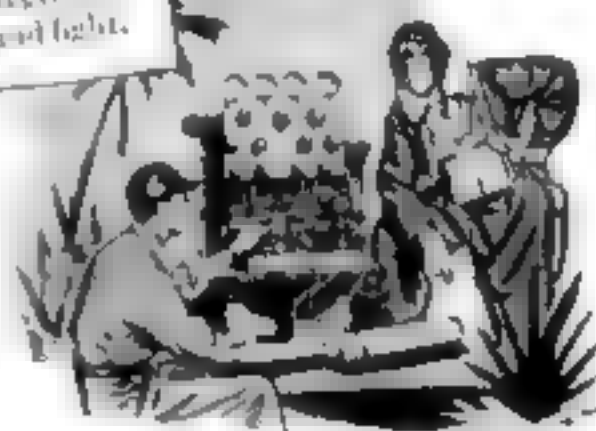


Coast Guard airports find a new job for the versatile jeep. They've manned it with asbestos-clad firefighters, loaded it with Kidde carbon dioxide extinguishers. This tough little "fire engine" can rush right up to crash-fires or other blazes, hit them hard and fast with fire-smothering carbon dioxide gas.



Cargo fire reports itself! First puff of smoke, sucked up to bridge, raises alarm, locates blaze. The Rich Audio System does it. It's a Kidde product.

Re-fill for fighting lungs! War planes fly high, need lots of oxygen. Kidde compressors deliver it - surgically clean - wherever our men fly and fight.



Gases-under-pressure, harnessed by Walter Kidde & Company, are serving our fighting men in many ingenious ways. After the war they'll serve you. Look for them!

WALTER KIDDE & COMPANY, INC., 140 CEDAR ST., NEW YORK 6, N. Y.



NAVAL AVIATION



WHERE PERFORMANCE REALLY COUNTS



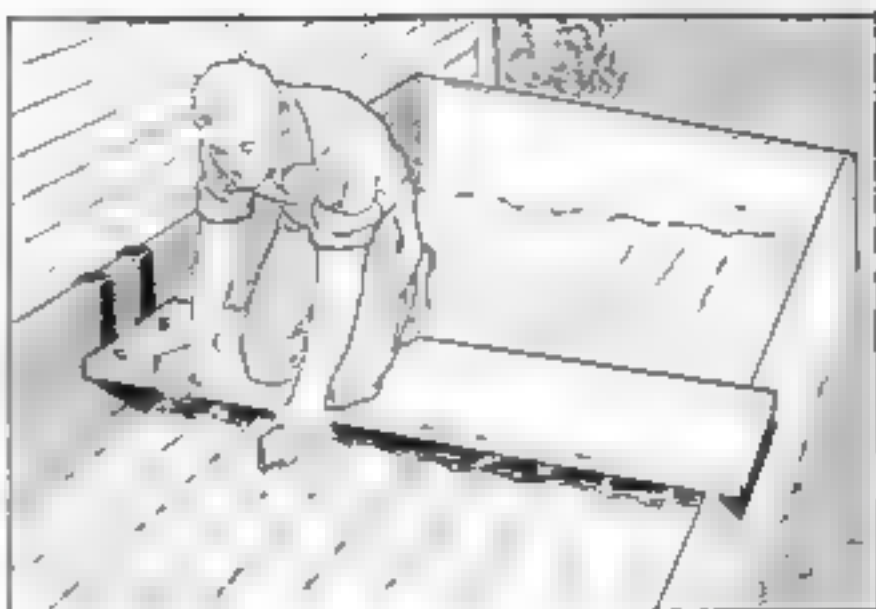
COUNT ON DEPENDABLE CHAMPION SPARK PLUGS

Full throttle, the jarring, explosive push of the giant catapult, and a Navy scout plane is airborne to search the seas ahead for lurking submarine or other enemy craft. In the few seconds after launching, the plane actually drops slightly, then the full power of the engine takes hold. This is no place for spark plug failure. Dependable Champion Spark Plugs, true to their more than thirty-year-old heritage, are designed to meet extreme as well as normal service. The records of our armed forces in the air, on the land and on the sea provide dramatic daily evidence that where performance really counts, you can count on dependable Champion Spark Plugs.



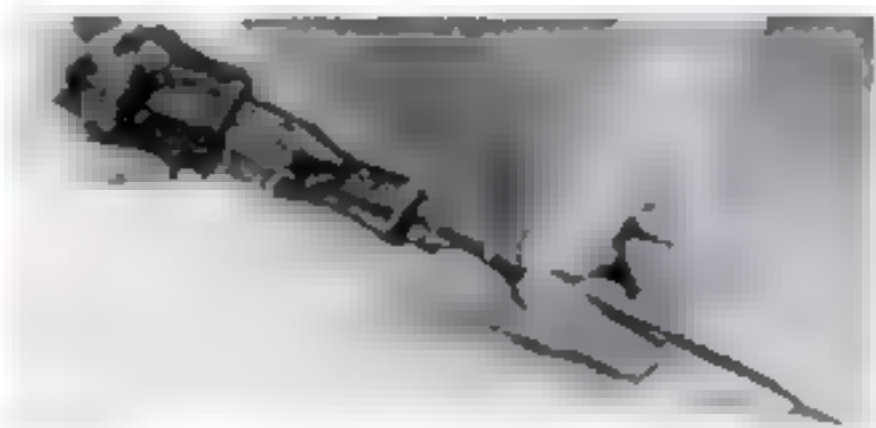
BACK THE ATTACK WITH WAR BONDS
BUY MORE THAN BEFORE

Movable Hotbed Work Plank



THIS work plank is made from a board that is a few inches longer than the width of the hotbed, two bent lengths of strap iron, and four bolts. The strap legs that are visible are long enough so the board, when in place, is level.—H. W. SWOPE.

Nonslip Grip For Screwdriver



PLACE a rubber crutch tip over the handle of your screwdriver to serve as a nonslip grip when your hands are sweaty. It will also prevent your palm from becoming sore when you are applying pressure to the butt for any length of time.—W. S.

15

Model Builders Attention!



Actual Size V-Plug

	V	V-2	V-3
Hex	$\frac{1}{2}$ "	$\frac{3}{8}$ "	$\frac{3}{16}$ "
Thread	$\frac{3}{8}$ " 24	$\frac{1}{4}$ " 32	$\frac{1}{4}$ " 32
Thread Length	$\frac{7}{32}$	$\frac{7}{32}$	$\frac{5}{32}$
Weight, Grams	8	$1\frac{1}{2}$	$2\frac{1}{2}$

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Silliment sealed, Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One piece construction.

CHAMPION

SPARK PLUG COMPANY • TOLEDO 1, OHIO



G.I. Joe and his 12 tons of baggage

WHEN an American soldier goes overseas, between five and twelve tons of equipment must go with him. And...

Another ton must be sent to him every month, in food, clothing, and ammunition.

Who sees that he gets it?

The colossal task of supplying our millions of men is the responsibility of the *Army Service Forces*. Theirs is the job of designing, procuring, and transporting every item of Army equipment except airplanes and items peculiar to the Air Forces.

From the time a soldier is sworn in, until his discharge, the ASF takes care of him. It feeds him the world's best army food, outfits him with the finest clothing, and supplies him with the most modern weapons.

The ASF delivers a soldier's mail, pays him, provides religious services for him, and gives him the best of medical care.

The ASF is the biggest business in history. Without batting an eye, it fills rush orders from all over the world for stupendous quantities of some *half a million* different items.

Because the outcome of battles depends so much on getting supplies *where* they are needed, *when* they are needed, the motto of the ASF is "Enough and On Time."

The amazingly efficient way in which the men of the ASF are living up to their motto has made today's American soldier the best-fed, best-clothed, best-equipped, and best-cared-for fighting man in history.

★ *Back the attack!*—BUY MORE THAN BEFORE! ★

SPERRY

C O R P O R A T I O N

30 Rockefeller Plaza, New York 20

This message is published by Sperry to foster a wider appreciation of the Army Service Forces as the vital link between the production front and the fighting front. Sperry co-operates with the ASF through these divisions:

FORD INSTRUMENT CO., INC.

SPERRY GYROSCOPE CO., INC. • VICKERS, INC.

Waterbury Tool Division, VICKERS, INC.

FIGHTING EDGE

U. S. Army pilots have flown more Allison-powered fighter planes into battle than planes powered by any other engine.

★ Pilots like Allison *reliability* to get there and back—*durability* to stand up under more fighting hours—

economy to extend range — *smoothness*

to reduce pilot fatigue. ★ This

numerical superiority and these

Allison qualities

have added much

to America's

fighting edge.

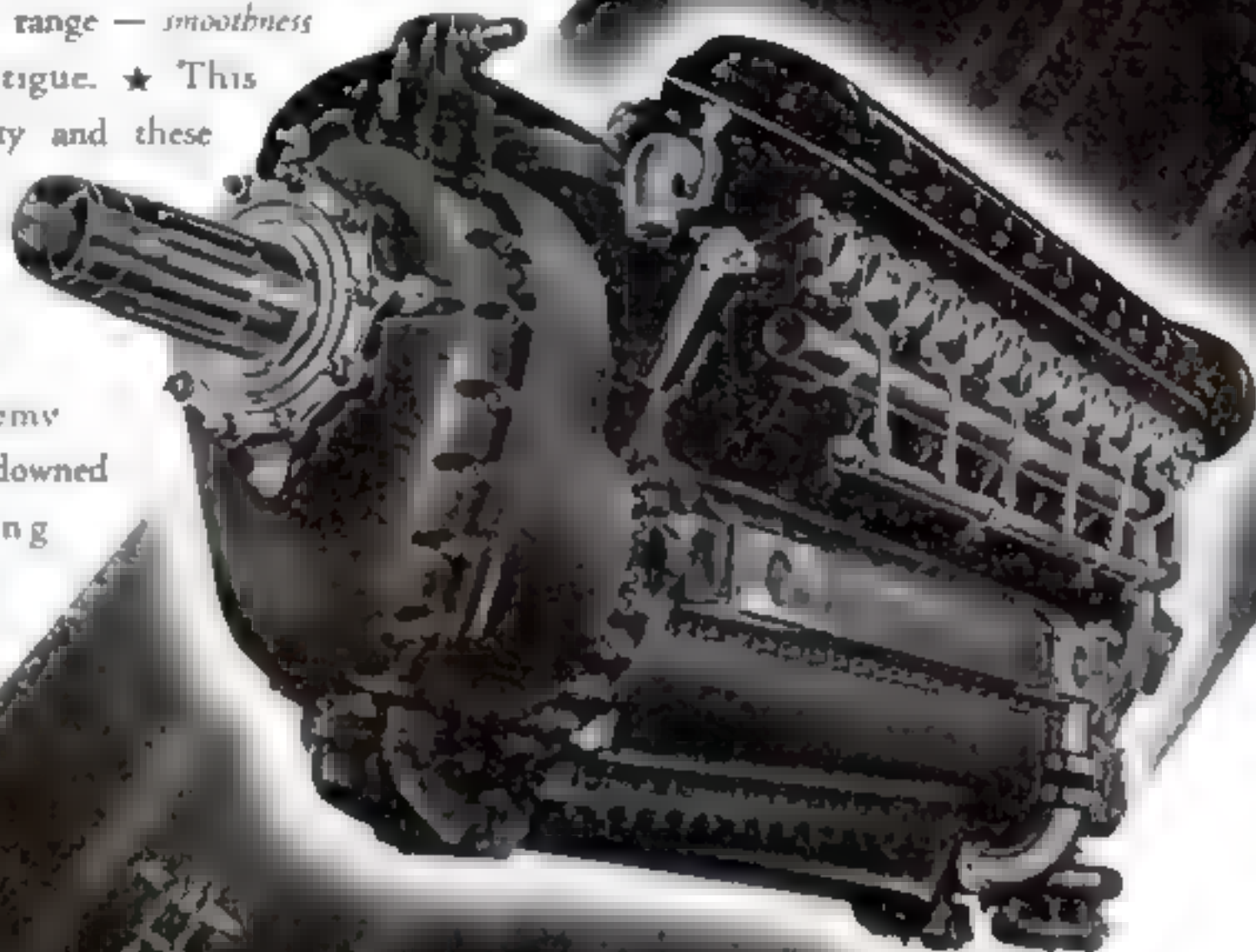
Thousands of enemy

planes have been downed

by pilots flying

Allison-powered

fighters.



POWERED BY ALLISON

P-38—Lightning

P-39—Aircobra

P-40—Warhawk

A-26 and P-51—Mustang

P-63—Aircobra

Allison has already furnished more than 50,000 engines for use in these planes.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF

Indianapolis, Indiana

Every Sunday Afternoon

GENERAL MOTORS SYMPHONY OF THE AIR—NBC Network



**KEEP AMERICA STRONG
BUY MORE WAR BONDS**

Here's how your car FEELS...

...after **MARFAK** chassis lubrication!

It drives so smooth and effortlessly, fairly soars along — after a MARFAK job. Yes, Texaco MARFAK chassis lubrication is great at making life easy for your car. Because MARFAK is extra tough and longer-lasting, it helps your car *live* longer too! MARFAK is applied by chart, never by chance. From king pins to rear shackles, every point of wear, every point of adjustment is checked when you ask your Texaco Dealer to give your car that "MARFAK feeling." Ask him today!

THE TEXAS COMPANY



TUNE IN the TEXACO STAR THEATRE starring James Mellon every Sunday night. See your local newspaper for time and station.

SEPTEMBER, 1944

Buy War Savings Bonds and Stamps regularly.

221

BUILDING AIR POWER WITH ELBOW GREASE



Photo courtesy Republic Aviation Corp.—
Special-file operation on edge of swelling.

THE mass-production of airplane, tank, truck and engine parts by automatic-machine operations excites wonder. But it still takes human skill, good hand tools and plenty of "elbow grease" to "put things together." Knowing the *right* tool for each job is of first importance in any mechanical "I.Q."

Files . . . there are *several thousand* kinds, cuts and sizes. Yet, to keep up with the new materials and production problems of this skilled-mechanics era, Nicholson still finds needs for files of new design or characteristics.

FREE BOOK, "FILE PHILOSOPHY"—for production and purchasing heads, foremen, key mechanics.

NICHOLSON FILE CO., 11 Acorn St., Providence 1, R.I., U.S.A.
(Also Canadian Plant, Port Hope, Ont.)

NICHOLSON FILES FOR EVERY PURPOSE

**NICHOLSON
U.S.A.
MADE IN U.S.A.**

Will Airborne Police Enforce World Peace?

(Continued from page 77)

volunteers, between 18 and 32 years old, above average in intelligence, and the alumni of extremely strenuous physical training camps. Every wearer of a paratrooper's wings has stepped out of an airplane in flight at least five times.

When going into battle, these men literally march out the instant a red light flashes to notify them they are over the DZ. They descend beneath blossoming 24-foot silk canopies with knives, explosives, rifles, carbines, and new folding bazookas.

Every man carries 75 or more pounds of gear down with him. More weapons, ammunition, and supplies descend alongside him in 300-pound bundles under separate, 18-foot rayon parachutes. Among these weapons are machine guns, antiaircraft guns, and both 60- and 81-mm. mortars.

A 75-mm. howitzer and its ammunition are dropped in nine packages. Six of these are carried under the plane's belly, held tightly in cup-shaped pararacks by steel bomb shackles. These may be released either by flicking electric switches inside the plane or by yanking hard on a manual control. The three other bundles are stacked in the plane and shoved out the door. An intricate system of linking the bundles together prevents them from landing more than 660 feet apart, even though each one rides under a separate parachute.

Paratroop artillerymen jump from the same plane that drops these bundles and rip them open on the ground. From one bundle they take the howitzer's rear trail, from another its front trail, from another the tube, and from another the wheels. They can assemble this fieldpiece in the dark with a minimum of tools. Hooking themselves to it by harness straps, like children playing horse, they can race it into position. One of the ammunition boxes, meanwhile, can be converted into a two-wheeled cart and used to haul fiber cases of shells up to the howitzer. With this weapon's 14-pound projectiles, a good crew can split a hair at 7,000 yards or plug a hole at 9,000 yards.

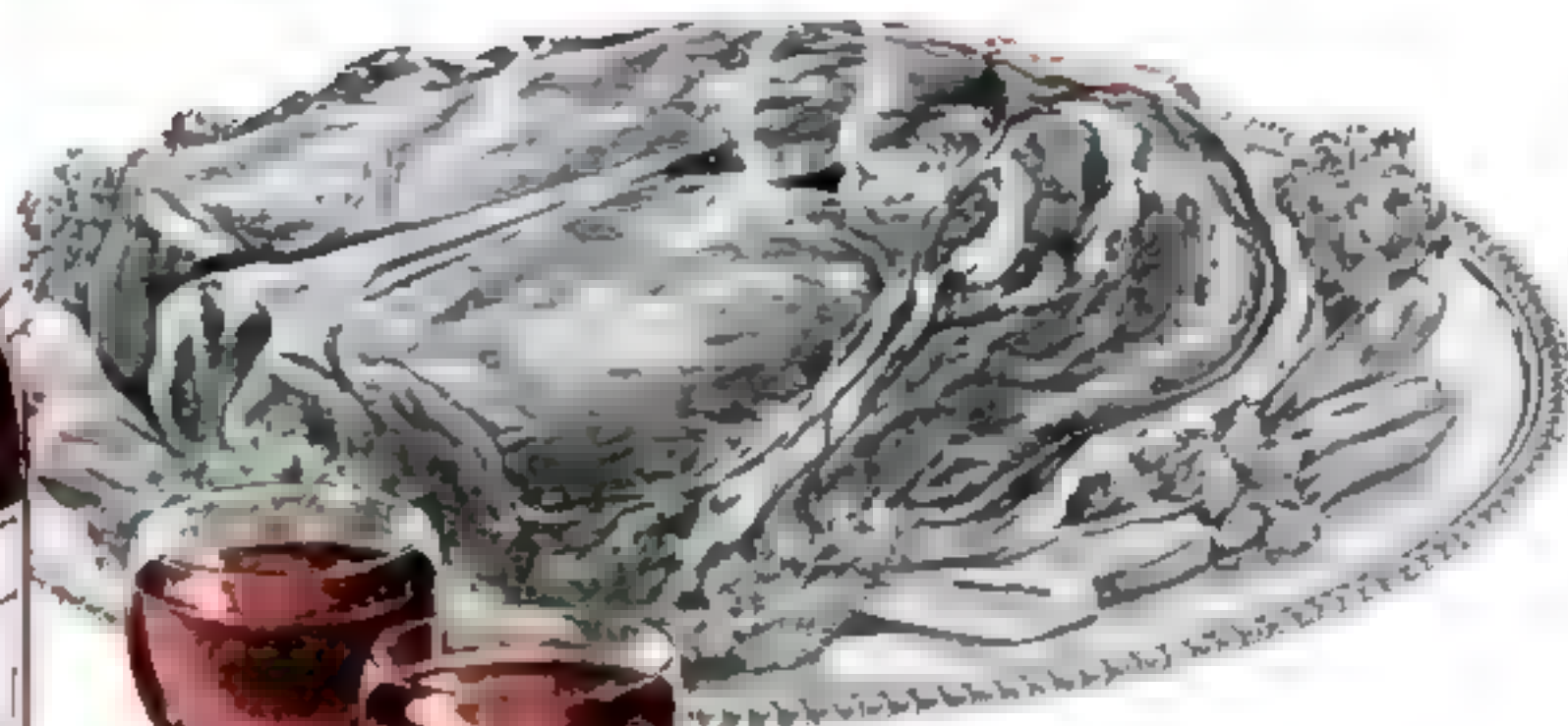
This howitzer is the heaviest of our paratroops' regular equipment. Germans are reported, however, to have dropped a 2½-ton truck beneath a triple 'chute. The best tricks of all are still up the American Airborne Command officers' sleeves.

Only two years ago, a glider capable of carrying nine fully equipped soldiers was

(Continued on page 226)

They're twice as good...together!

ROMA Wines



Easy, thrifty way to make meals taste twice as good!

WHEN dining alone, or when entertaining—here's a "plan" for the man who likes to make things: Tonight, make dinner taste *twice as good*—whether it be steak or stew, fish or fowl. Just serve a cool bottle of ROMA California Burgundy, Claret, or Sauterne with the meal! ROMA'S superb flavor, constant quality, and reasonable cost have made ROMA America's largest selling wines! Enjoy ROMA Wines daily with meals and when entertaining—for only pennies a glass! If your dealer is out, please try again.

**ABOVE ALL ELSE
BUY BONDS!**

ROMA California Wines include: Port, Sherry, Muscatel, Sauterne . . . Claret, Burgundy, Zinfandel . . . Champagne and Sparkling Burgundy.
ROMA WINE COMPANY
Fresno, Lodi, Healdsburg, California

R
ROMA—America's Largest-Selling Wines!



"You'll Go Places On This Team!"

1st Lt. Richard J. Niederriter, pilot, 1st Lt. Richard A. Carocari, navigator, Sgt. Richard W. Evans, tail-gunner, and 1st Lt. Lester A. Darst, bombardier, (left to right in foreground above) have hit most of Germany's "hot spots" in their Flying Fortress, the "Winsome Winn." Asked which was their most exciting mission, their answer was unanimous: "Anklam!"

"You probably never heard of Anklam," Lt. Carocari said. "Before the war it was just a little jerk-water town a hundred miles or so from Berlin. But the Nazis built a Focke-Wulf assembly plant there. And our assignment was to flatten it."

"I plotted my course for Berlin, to make Jerry think that was where we were heading. And we hadn't any more than crossed Denmark until the reception committee buzzed out to meet us. At least 800 German fighters hit our flight. They'd come barreling in from all directions at once... the fire from their cannons and machine guns making a solid sheet of flame along their wings. The going was hot and heavy for awhile."

"Hot and heavy is right," Lt. Niederriter said. "We were under fire for 3½ hours. But our gunners were too smart—and too good—for them. Evans here had his tail-gun knocked out, so he came up and fired the flexible gun in the nose. When the ball-turret got fouled up with oil from a damaged line, the ball-gunner adjusted it so it would keep revolving—to fool the fighters—and then he climbed out and lent a hand at the waist-guns. It was the prettiest piece of teamwork I've ever seen."

"That's what really licked 'em," Sgt. Evans said. "Teamwork! Lt. Niederriter had his hands full keeping the Winsome

Winn on her course... yet all the time, he sat up there and called the shots for us gunners. We sure did work those German fighters over. We saw two blow up in mid-air."

"Finally," Lt. Darst said, "we changed our course and cut for Anklam. The F-W's gave us a breathing spell as we swung in over the town and we made a nice, smooth bombing run. I saw our eggs land square on that factory. And, brother, did we plaster it! They won't make fighter planes there very soon again!"

Lt. Niederriter grinned. "Sure," he said, "you go plenty of places in the AAF. And it's not exactly joy-riding, either. But we've got a job to do. And we work together to do it."

"And I think that's the important thing for any young fellow—who wants to win his wings as Gunner, Bombardier, Navigator, or Pilot—to remember..."

"You're on a team in the AAF—from the time you step into your first training plane until you get up there in action. And it's a winning team... an unbeatable team... the 'greatest team in the world!'"

U. S. ARMY RECRUITING SERVICE



"They came barreling in from all directions."

MEN OF 17...



If you want to fly on the "greatest team in the world," an AAF air combat crew... go to your nearest AAF Examining Board... see if you can qualify for the Air Corps Enlisted Reserve. If you qualify, you will receive this insignia... but will not be called for training until you are 18 or over.

When called, you will be given further tests to determine the type of training you will receive. If you are trained as a gunner or technician gunner, you will go into actual combat as a non-commissioned officer. If

your aptitudes are outstandingly high, you will be trained as a bombardier, navigator or pilot, and upon successful completion of training, will be graduated as a Flight Officer or Second Lieutenant.

For pre-aviation training, see your local Civil Air Patrol officers. Also see your High School principal or adviser about recommended courses in the Air Service Division of the High School Victory Corps. Ask about the opportunities for college training through the Army Specialized Training Reserve Program.

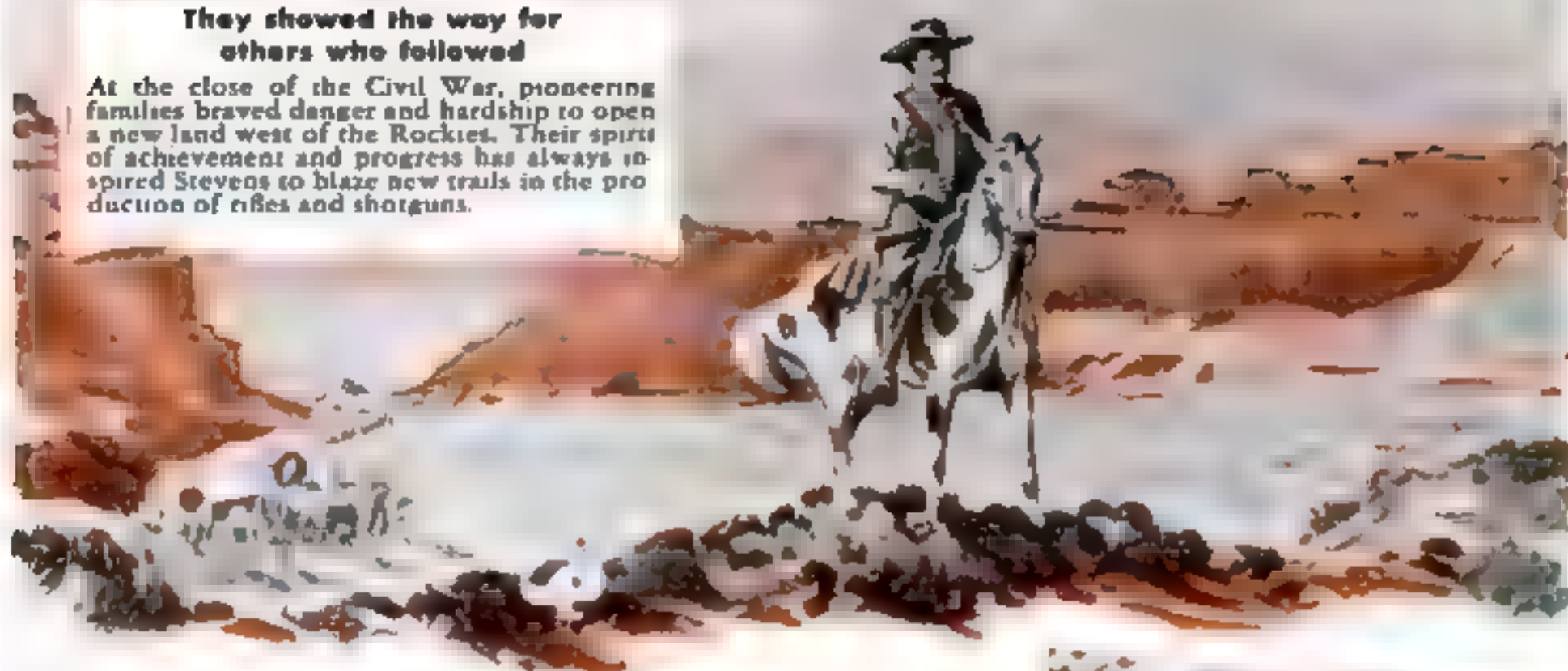
For information on Naval Aviation Training, apply at nearest Office of Naval Officer Procurement. This advertisement has the approval of the Joint Army Navy Personnel Board.

FLY AND FIGHT WITH THE

GREATEST TEAM IN THE WORLD

**They showed the way for
others who followed**

At the close of the Civil War, pioneering families braved danger and hardship to open a new land west of the Rockies. Their spirit of achievement and progress has always inspired Stevens to blaze new trails in the production of rifles and shotguns.



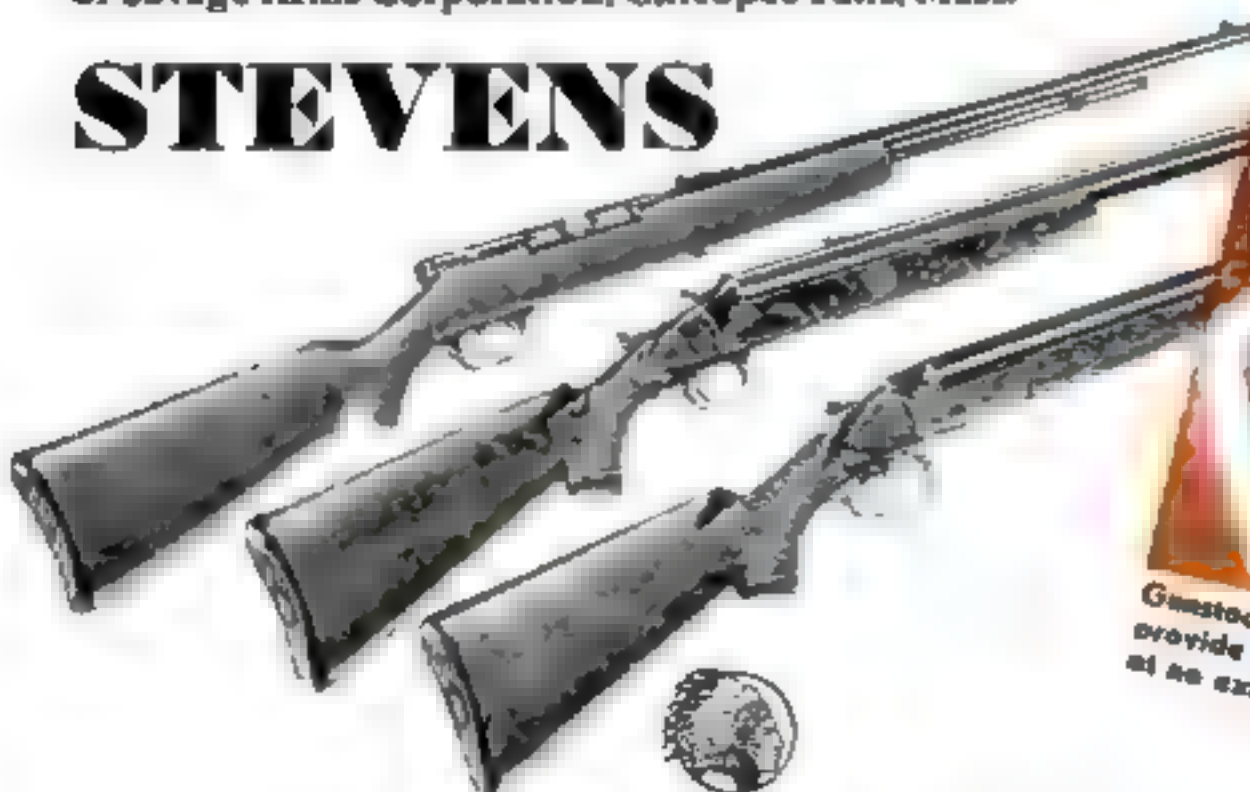
Pioneering for American Sportsmen

For more than 80 years . . . since the days when the covered wagons rumbled Westward . . . Stevens has been pioneering new frontiers in fine gun-making. In working out new models, and new and better ways to make them we have never followed the beaten trails. That's why four generations of American shooters have looked to Stevens for better rifles and shotguns.

Stevens-built *Springfield Brand* single and double barrel shotguns and rifles are among the most popular and widely used firearms in their field. New models, new improvements and better values have brought shooting pleasure to hundreds of thousands of users.

Since the start of World War II, we have been devoting all of our facilities to producing huge quantities of military rifles. As to the future . . . depend upon Stevens manufacturing skill and pioneering "know-how", sharpened by victory production, for even finer rifles and shotguns. J. Stevens Arms Company, Division of Savage Arms Corporation, Chicopee Falls, Mass.

STEVENS



"Speed shooting" with the Stevens automatic .22 caliber rifle. Great sport after the war.

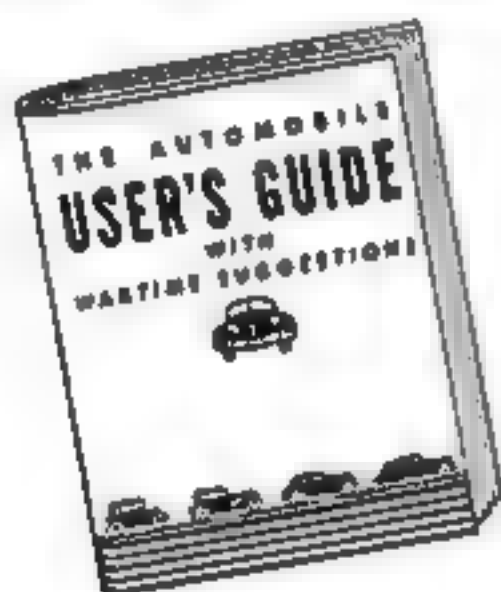


Ready for small game — winged or four-footed — with the Stevens No. 22-410 combination .22 caliber rifle and .410 shotgun.

Gunstocks of Tenite, the durable plastic, provide handsome checkering at an extra cost.

Will Your Car Outlast the War?

As a special wartime service to owners of **ALL MAKES** of cars, General Motors offers a new edition of The Automobile User's Guide, containing 196 practical suggestions on such subjects as *how to get better gasoline economy, how to prolong tire life, how to keep your car in the best operating condition, how to preserve exterior finish, etc.*



You can get your **FREE COPY** from any General Motors dealer or by using the coupon below.



Customer Research Dept., Room 1764

GENERAL MOTORS, DETROIT 2, MICH.

Please send **FREE COPY** of new 64-page
"AUTOMOBILE USER'S GUIDE"

Name please print

Address please print

City State

Make & Model
of Car Owned

Will Airborne Police Enforce World Peace?

(Continued from page 222)

"the largest yet built in this country" (P.S.M., Oct. '42, p. 70). The smallest glider now in constant use, the CG-4A, carries 15 fully equipped men. The biggest glider now in production, the CG-13, carries 30 fully equipped men, or two jeeps, or a 1½-ton truck. And there's absolutely no reason why even greater gliders cannot be built, towed, and landed on battlefields.

Glider troops are called "Glidiators," because their jobs are as strenuous and perilous as those of ancient gladiators. Another nickname is "Holmans." This moniker was suggested by a cartoon showing two birds perched on a wing, one of them saying: "Look, Holman, no motors."

These infantrymen fly to battle in unarmored cabooses that look as fragile as orange crates and bounce and sway like the Toonerville Trolley. But these thin-skinned craft are stouter than they look. A tubular steel frame makes the cargo compartment so sturdy that, even though the wings and tail are smashed to smithereens when the glider lands, the men in its fuselage may hop out of the V-shaped emergency doors unscathed. After this war, you may see battered glider fuselages towed down the street as fondly as veterans of World War I have paraded French 40-and-8 box cars.

An immense fleet of these dark-green, aerial freight cars can take off like a flock of birds. Loaded gliders are lined up on one arm of a Y-shaped runway. C-47 planes, looking no different from commercial airliners, taxi down the other arm to the intersection. Men run out and attach two gliders to each plane's tail by long nylon ropes. The plane roars off, and the gliders leave the ground before it does. Meanwhile, another plane and another pair of gliders have started down the runway.

With special instruments to show glider pilots their position in relation to the tow-plane at all times, these craft can be flown safely in fog and darkness. To reduce buffeting from the propellers' backwash, the gliders usually are held above or below the plane. Even so, the "Holmans" may have to tighten the straps that hold them on hard, plywood seats, to reduce the squeamish feeling in their innards. The Army is searching systematically for a sure means of preventing motion sickness, but none has been found yet.

Glider pilots free their craft from the tow plane by shifting a knob known as "the

(Continued on page 230)

**"THANKS FOR THE
LEAKPROOF BATTERIES!"**



THE FLASHLIGHT BATTERY THAT

STAYS FRESH FOR YEARS

BECAUSE IT'S LEAKPROOF

Here is a battery that our fighters stake their very lives upon. It powers Flashlights, Field Telephones, Flame-throwers, and many other vital war weapons. You can't have LEAKPROOFS for your flashlights now, but millions of our men at the front thank you for your sacrifice.



RAY-O-VAC COMPANY, MADISON 4, WIS., Other Factories at CLINTON, MASS., LANCASTER, OHIO, SIOUX CITY, IA., FOND DU LAC, WIS., MILWAUKEE, WIS.

SEPTEMBER, 1945

Buy War Savings Bonds and Stamps regularly.

227

FLASHLIGHTS  BATTERIES

HERE'S

BEEN A

BIG CHANGE



THE old-fashioned phonograph played sweet music in its day. But with the advent of the radio, home entertainment took on a new significance.

The most significant change in tapered roller bearings in recent years is Tyson's extra rolls—actually thirty percent more

around the raceway. That's important. For it's the rolls that carry the load.

Today users of heavy-duty equipment are amazed at the sustained efficiency of these Tyson "All-Rolls" Bearings under most exacting operating conditions.

The big name in bearings today is . . . TYSON!



TYSON BEARING CORPORATION • MASSILLON, OHIO

COUNT THE ROLLS THE ROLLS COUNT



Tyson

TODAY'S HEAVY-DUTY BEARING

★ BUY MORE WAR BONDS ★



On moving day, a thousand things
Must be wrapped securely,
But Texcel Tape will seal them all,
Quickly, neatly, surely!

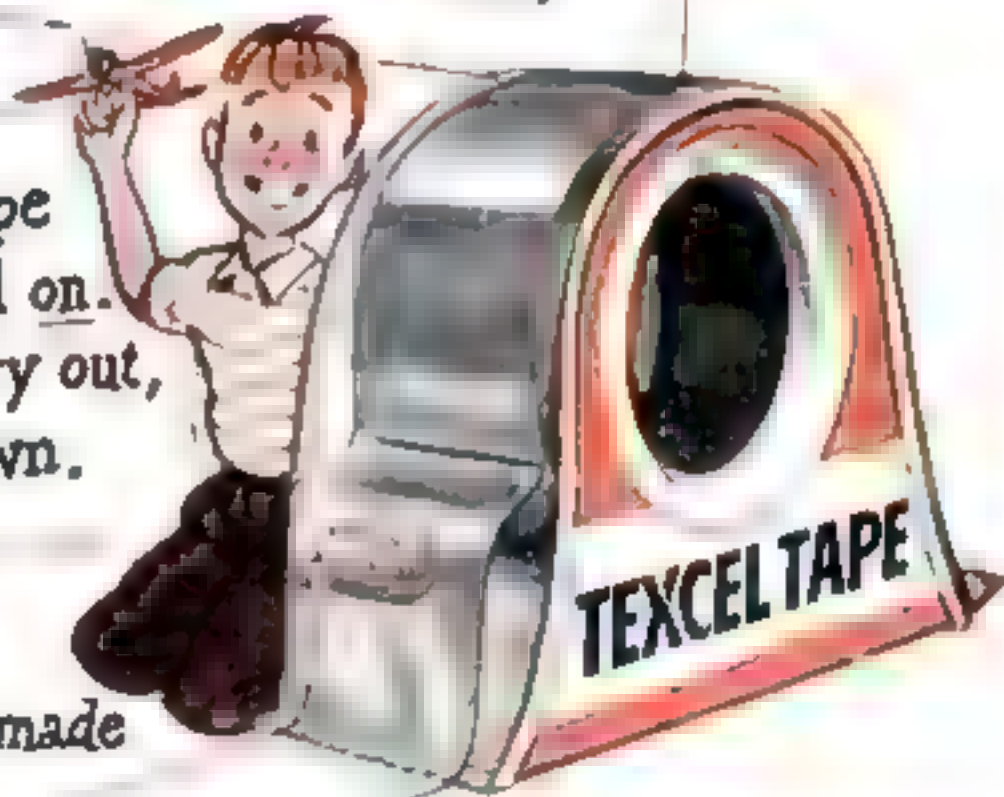
If precious stockings should get caught
On parts of desks or chairs,
Just shield rough spots with Texcel Tape—
No snags, no runs, no tears.



For keeping licenses unsoiled,
For keeping passes sealed,
You'll find in sturdy Texcel Tape
A safe, transparent shield.



For Texcel is an improved tape
Whose "stick-um's" bonded on.
It won't come off, it won't dry out,
It's one, like grass and lawn.



Since all the Texcel Tape that's made
Is being used for war,
Buy Bonds and Stamps 'til Victory
Returns it to your store.

Made by
Industrial Tape Corporation
A Division of
Johnson & Johnson
New Brunswick, N.J.

Texcel Tape

CELLOPHANE TAPE — STICKS WITH A TOUCH

Nowhere is reliable performance more indispensable than with America's buses. So, there is a tip for you in the way the bus transportation industry cares for spark plugs. All plugs are thoroughly cleaned and accurately adjusted every 3,000-5,000 miles. When plugs are finally worn out, new ones are installed promptly,—and thousands of them are AC Spark Plugs.

Follow this same system with your own spark plugs, and you will not only enjoy the utmost in plug reliability but also conserve urgently needed materials and fuel for our fighting men.



BRING YOUR FIGHTING MAN HOME SOONER
BUY ANOTHER WAR BOND

Will Airborne Police Enforce World Peace?

(Continued from page 226)

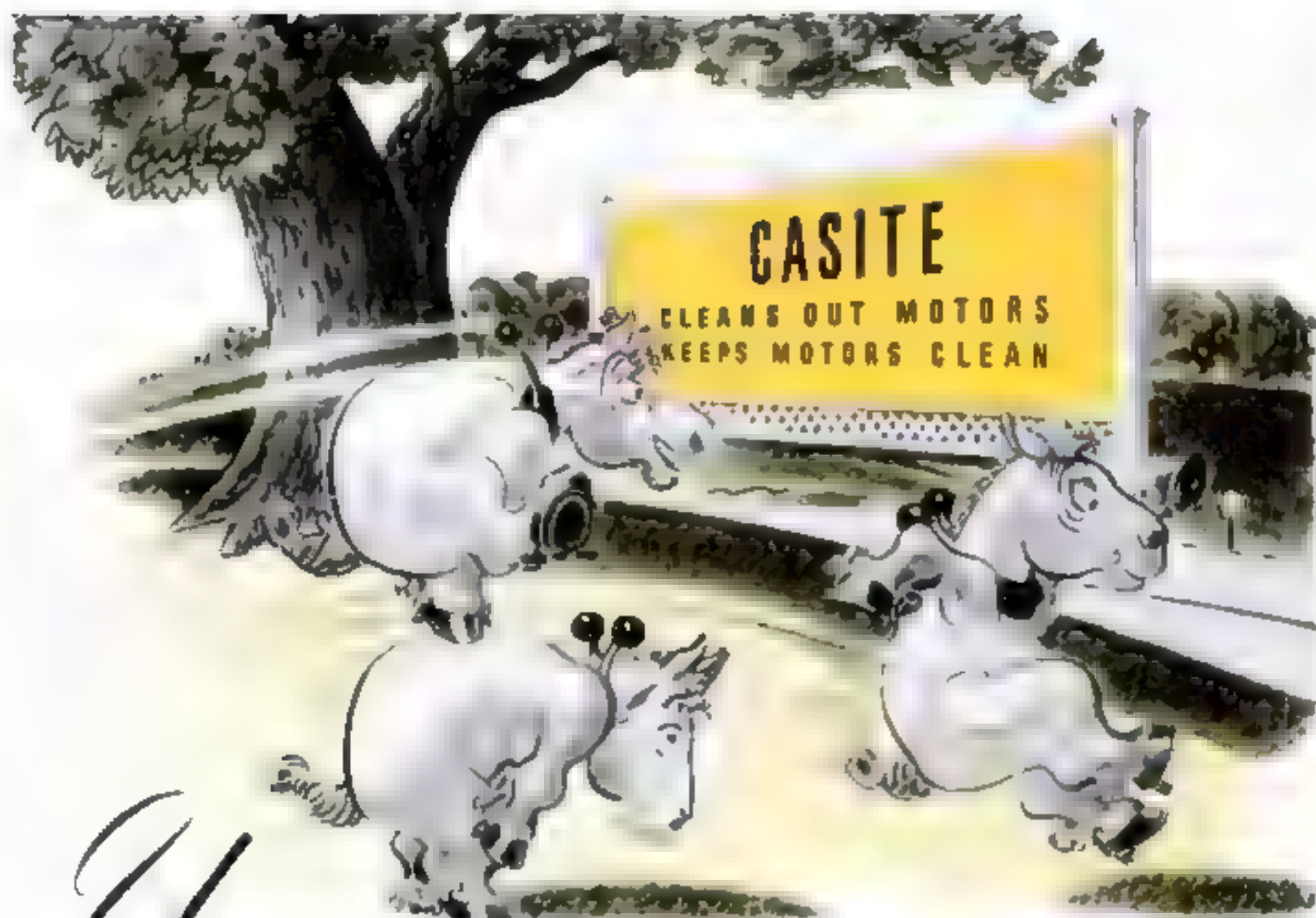
eight ball." From an altitude of two miles, a glider can coast 30 miles before landing. This 15-to-1 descent ratio can be cut, however, to 4-to-1 by using "spoilers" on the wings. A whole fleet of these craft can swoop into a field without making any more noise than a gentle breeze passing a tree.

The instant a CG-4A lands, a jeep inside it may start forward. A cable attached to the rear of the jeep raises the glider's 400-pound nose. The cable then detaches itself from the jeep automatically, and the car and men in it dash off without pausing. A big CG-13 lands with its nose haughtily tilted in the air. But hydraulic apparatus inside the glider raises that nose majestically, plywood ramps are thrown out, and equipment rolls down them.

The engineers have portable air compressors to run saws, drills, and other machines and inflate rubber boats. They have water-purification and construction tools as well as demolition devices. The doctors have a 25-bed hospital that is carried in 34 packs weighing from 35 to 85 pounds. It includes operating instruments, a stove, a sterilizer, and even a typewriter. An expensive chemical concentrate that can be substituted for blood plasma is used because it is easier to carry. Other specialists have comparable special equipment.

Improvements are being made constantly. Colored parachutes enable our men to identify parachuted matériel quickly on the ground. The color scheme can be changed before each mission to fool the enemy. For some jobs, Americans also have camouflaged parachutes. Among the recent improvements in glider transportation are crash skids that protect the Plexiglas noses of the craft, tricycle landing gear with improved brakes, and separate rather than Y-shaped towlines to reduce sudden strains on an airplane hauling two gliders.

Because of these astounding advances in the technique of using airborne forces and the great combat record of our paratroopers and parachutists, we now have a completely organized, separate Airborne Army under the command of Lt. Gen. Lewis H. Brereton. Composed of American, British, and Canadian personnel, the new unit approximates a full army in size and importance—possibly 250,000 men. Instead of being divided among various ground commands, the combat troops, planes, and gliders are under one command—a huge, unified airborne striking force.



Young horsepower for old cars

Ever see the inside of your motor? Well, it's a maze of little pipes and passages that choke up with power-destroying sludge and gum. You can clean these out, and keep them clean, with Casite.

**Better and Smoother Performance
or Double-Your-Money-Back**

It's as simple as that. Either your motor

runs better and smoother, or you get back twice what you paid. Used through the carburetor, Casite gives an effective tune-up at low cost. Added to the crankcase oil, it stays on the job from one oil change to another.

Sold by service stations, garages and car dealers coast-to-coast at 65¢ a pint.

THE CASITE CORPORATION • HASTINGS, MICH.

Guarantee

Add Casite to crankcase and run through carburetor according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double your money back by filling out guarantee certificate and mailing it to The Casite Corporation, Hastings, Michigan. Maximum refund is \$1.30 per pint, twice the nationally advertised price of Casite.



WHEN YOU GET CASITE AND GO!

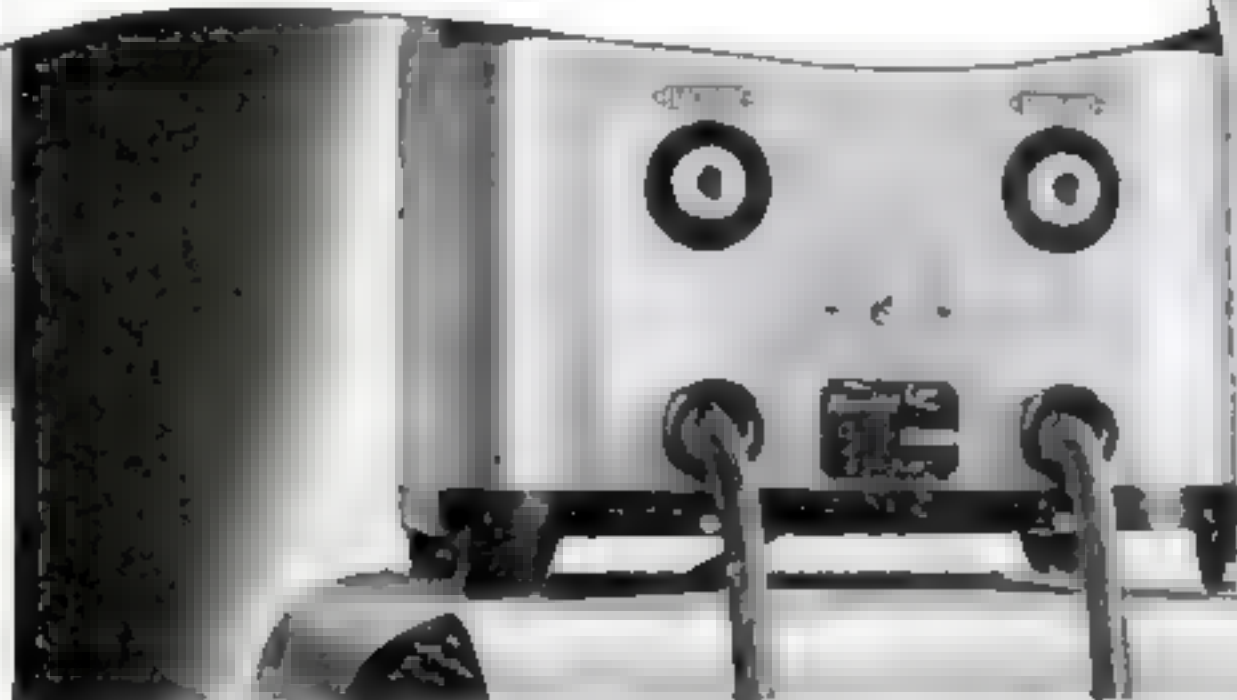


IT'S A PRIVILEGE

TO BUY WAR BONDS

Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



Revolutionary Hy-cycle Automatic Arc Provides Complete Control of Arc and Heat

At last, a development that automatically starts the arc before the welding electrode actually comes in contact with the work! Eliminating the "pecking" or "scratching" that so often creates tension and operator fatigue. Its many advantages contribute largely to saving time and labor because an operator can be trained in far less time than usual, and higher speeds can be obtained. This hy-cycle automatic arc unit, called "Missing Link," permits the operator to weld with any welding rod, bare steel or alloy. Rods that could not be used before can be burned with ease—such as bare mild steel, dust coated, reverse polarity, aluminum, bronze, stainless steel, etc., AC or DC.

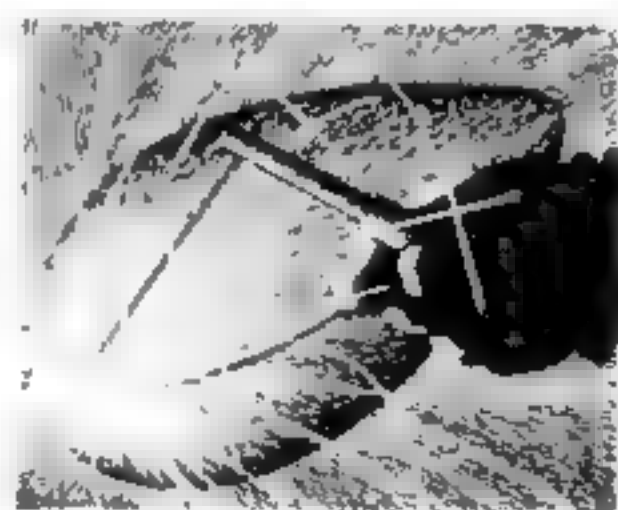
One of its most important advantages is welding light gauge. Light gauge requires low heat—making many jobs almost impossible for ordinary methods. Since the "Missing Link" starts automatically on as low as one ampere of heat, the welding of light gauge sheet can be done with surprising speed with no time out for "pecking" and "sticking."

You all know that our fighting men need the finest quality materials that we here at home can produce. That goes for Wrigley's Spearmint Gum, too. Although our stock pile of quality raw materials is getting lower and lower we are maintaining our standards of quality. Naturally, we are forced to limit production. So we are giving priority where it is needed most—and where you want us to—our fighting men and women overseas only. Because chewing gum is essential to them—they are getting all of our limited production of Wrigley's Spearmint Gum.

You can get complete information from Mid-States Equipment Company, 2429 South Michigan Avenue, Chicago 16, Illinois.



Simplifies welding vertical and overhead



Makes it easy to weld light gauge work

Y-136



Once they crowded the shoreline, watched him out-distance all challengers—spurt past the final buoy. Now, in time of war, his ability and skill are put to a more difficult, desperate task. He looks different. But his character is unchanged. Plumb, too, has donned a service uniform. Some of the fine finish is gone for the duration—by Government Order.

But the quality of each Plumb tool is the same. The expertly-shaped hickory handle, the one-piece steel head—tempered with exactness and skill. The hang. The perfect balance. For over eighty years master craftsmen have made Plumb tools—and zealously guarded these secrets.

Yes, appearance has changed slightly—but Plumb is proud of its service uniform. Fayette R. Plumb, Inc., 4937 James Street, Philadelphia, 27, Pa.



PLUMB TOOLS ILLUSTRATED Top to Bottom: Nail Hammer, Nail Hatchet, Bell Pine Hammer, Single Ed. Michigan Axe

PLUMB

HAMMERS • HATCHETS • AXES • SLEDGES



A ship is a world

To her crew a warship means everything—home, food, protection, life. She's a world in herself, wherever she sails on the seven seas. She must stand alone—she must meet the strains and stresses of the sea, the weather and the war. The safety of the ship—the lives of men—depend upon the enduring qualities built in by skill, experience and integrity. That is why, here at Defoe, men and women put heart and pride into the construction of every Destroyer Escort and LCI (L) Landing Craft launched. The vital responsibilities of the shipbuilder's art will tolerate only craftsmen who build well. For these reasons whatever Defoe produces after the war will have the advantages of staunch dependability . . . of better quality and value for peacetime America.

DEFOE SHIPBUILDING COMPANY, BAY CITY, MICHIGAN

INVEST IN INVASION
—BUY WAR BONDS

Defoe



*Four White Star Renewal Citations
now decorate the Navy "E" Award
won by Defoe workers.*

SHIPS FOR VICTORY
SERVANTS FOR PEACE

Now, Through ZENITH RADIONIC RESEARCH ... A QUALITY HEARING AID

Both Millionaire and Average Worker Cheer!



Note Zenith's New NEUTRAL-COLOR EARPHONE and CORD. Blends with any complexion. No extra cost.

**Yes, Both Choose the New Zenith Radionic Hearing Aid
Because of Zenith's Leadership in Radionics**

AMERICA's hearing aid wearers ... regardless of income or walk of life ... have found a common bond in ZENITH QUALITY!

Many who wore the highest-priced hearing aids are now wearing the new Zenith Radionic.

How can Zenith give so much for so little? First, because all of Zenith's great engineering skill is concentrated on "Radionics Exclusively." Second, because a hearing aid is essentially part of a radio. And Zenith is the company where leadership in precision mass production lowered the price of a \$200 radio to \$29—and made it a better instrument.

A parallel example is that of the fine watch and automobile manufacturers. The watch you carry is a precision mass production product. Otherwise, it would cost you ten times as much and not be as accurate. Zenith has applied the principle of precision mass pro-

duction in "Radionics Exclusively" to hearing aids. From a hand-made first model costing over \$50,000 to build, the Zenith has become the world's most popular hearing aid and an even finer instrument at \$40!

What's more, you can fit the Zenith yourself, adjust it INSTANTLY for different voices and surroundings as easily as you focus binoculars! This eliminates salesman's high commissions. It ends the need for elaborate testing and frequent "tinkering" by high-pressure attendants, costly home calls and other expensive "trimmings."

The result—Zenith's HIGHEST QUALITY, within reach of all! You owe it to yourself, your friends, to investigate. They want to enjoy your company as much as you want to hear them. Get a thrilling demonstration today. Or send the coupon below for free, complete details by mail.



\$40 Complete, Ready-to-Wear

... with NEUTRAL-COLOR EARPHONE AND CORD—smartly styled, scarcely noticeable. Complements any complexion, has new "look of youth." Plastic earphone is light comfortable, long-wearing. Plastic cord is kink-proof, washable, perspiration-proof. Gives far less clothing or friction noise than the old type of fabric-covered cord.



Also available, the New Bone-Air Zenith—for the very few who require this special type instrument \$1.00 more, complete.

CANADIANS! The New Zenith Radionic Hearing Aid is now available in Canada—direct by mail only—at \$40 complete (Canadian currency) with no additional charge for transportation, duties or taxes! For details write our Canadian distributor, Dept. PS-8, Zenith Radio Corporation of Canada, Ltd., Guaranty Trust Building, Windsor, Ontario.



ZENITH RADIO CORPORATION, CHICAGO, ILLINOIS

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PASTE ON PENNY POST CARD AND MAIL

Zenith Radio Corporation, Dept. PS-8
P. O. Box 6940A, Chicago 1, Illinois
Please send me your Free descriptive
booklet on the New Zenith Radionic
Hearing Aid.

Name _____
Address _____
City _____ State _____
☐ Physicians check here for literature



His message must get through! Lack of a "Walkie-Talkie" battery might mean death . . . not for one man but for thousands! The very dry cells that normally go into your batteries now supply the vital voltage for "Walkie-Talkies." That means limited supplies "over here," so use your available Burgess Batteries sparingly . . . handle them carefully as eggs. For Free Battery Hints — Write Dept. H-1, Burgess Battery Company, Freeport, Ill.



BURGESS BATTERIES

IN THE NATION'S SERVICE
On the Fighting Front
On the Home Front

How Robot Weapons Are Changing Warfare

(Continued from page 71)

alledgehammer smashing through a plate of glass.

On land, a folding bazooka of 2 3/8-inch caliber, latest version of our famous anti-tank weapon, makes the lightweight rocket launcher even easier to carry over jungle trails. Artillery rockets of large caliber are now fired in salvos by highly mobile land projectors. But the giant of them all would be Germany's threatened V-2—a long-range, 30-ton rocket carrying 10 tons of explosive.

British military observers did not laugh off this "Buck Rogers" rocket—a fact significant enough, since their intelligence service proved sufficiently alert to detect preparations for the V-1 attack in time for bombers to knock out the majority of the launching sites before the invasion. Possible evidence of plans for the V-2 lies in the discovery of huge unfinished emplacements of steel and reinforced concrete, which could serve as launching platforms. One of a number on the Cherbourg peninsula had an inclined concrete ramp 700 feet long, 70 feet wide, and 50 feet deep—certainly too large for the needs of launching any smaller rocket or flying torpedo. Therefore it would be rash to deny the possibility of such a super-rocket. Rising to the stratosphere and then plunging vertically toward the earth, it would be almost an impossible target for defending planes and antiaircraft artillery. Against such an appalling menace there can be only one defense—to stamp out the places where the rockets are made and launched, first by demolition bombing and finally by armed occupation.

Since the beginning of the present war, airplane bombs have grown to the staggering size of 12,000 pounds—and there seems no reason for stopping there, for only the carrying capacity of a plane limits their weight. Burying themselves in soft ground, they produce earthquakes that tumble building walls and shatter underground water and gas mains. Dropped in water near "bombproof" submarine pens, they create artificial tidal waves that hurl the moored craft to destruction. In addition to sheer bigness, new explosives of unprecedented power have augmented their terror.

Imagine a man, bearing no visible marks of injury, lying stone dead on the pavement after an air raid. No bomb has hit him, the nearest one landed far away; and he did not die of heart failure. Instead, he was a victim of the dread "blast effect" pro-

(Continued on page 238)



THIS NUT IS

Alive!

Why? Because It's a **SPEED NUT**

SPEED NUTS are made of heat-treated, live spring steel. They have a live arched spring lock and an inward thread lock. Live spring action absorbs vibration instead of merely resisting it.

Before Pearl Harbor, over two million a day were used on automobiles, refrigerators, stoves, heaters, radios and hundreds of other products. When the shooting is over,

still more will be used because more engineers have learned that SPEED NUTS are lighter, double-locking and faster to apply. And in addition to all their exclusive advantages, SPEED NUTS still cost substantially less than other self-locking nuts. Write today

TINNEMAN PRODUCTS, INC.
2022 Fulton Road, Cleveland, Ohio

In Canada: Wallace Barnes Co. Ltd., Hamilton, Ontario
In England: Symmonds & Co. Ltd., London



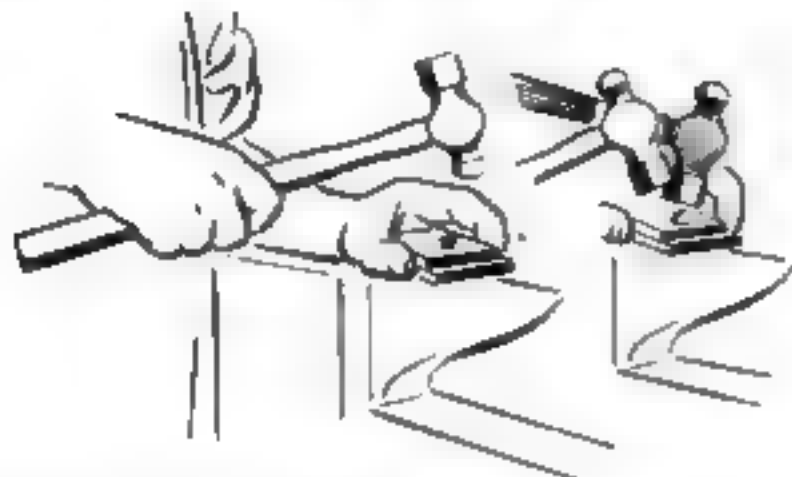
Speed Nuts[®]

F A S T E S T T H I N G I N F A S T E N I N G S

*Trademark Reg. U. S. Patent Office

Tool Tips by STANLEY

Use of Ball Pein Hammer



To rivet with a ball pein hammer, place the parts together with the holes in line and insert the rivet. Support the head of the rivet on a solid object, such as a vise anvil, and strike straight down on the rivet with the ball pein; head the rivet over with the ball pein or with the hammer face.

To raise a curved or bowl-shaped form in malleable metal, hold the work over a suitable hardwood form and beat it out with the ball pein.

The Stanley Tool Guide Shows Proved Tool Methods Galore!

More than 200 illustrations, with practical instructions covering the use of boring tools, doweling jig, spoke shaves, scrapers, planes, marking gauge, chisels, and other commonly-used hand tools are included in this one book. Send for your copy today, 25c postpaid.



*A Big Value
for only 25¢*

STANLEY TOOLS

294 Elm St., New Britain, Conn.

Enclosed find 25c. Please send me the Stanley Tool Guide, postpaid. (In Canada: Send coin or stamps to Stanley Tool Co. of Canada, Roxton Pond, Quebec.)

Name

Address

City State

How Robot Weapons Are Changing Warfare

(Continued from page 236)

duced by some of the newest bombs. An autopsy reveals that the cause of death was severe internal injury, especially to the lungs.

Recent studies show there is no mystery about this blast effect, that it is not always fatal, and that common-sense precautions can prevent any injury at all. Actually the blast is simply an ultrafast and powerful sound wave, produced when an explosive detonates with extreme velocity.

Now, every schoolboy knows that sound travels about 1,100 feet a second through air under normal circumstances. But a superquick explosion transforms ordinary air into something of quite different elasticity and pressure, the two factors of a well-known physical formula for the speed of sound in any material. This checks with the observed fact that the blast wave may travel, not at the normal speed of sound, but as fast as 20,000 feet a second. Its impact upon the human body is exactly the same as a physical blow. Since most of the body is solid, and the only empty parts are the lungs, a blast wave bruises the lungs through the chest wall. Fortunately the lungs can stand considerable bruising, and most blast cases recover. From a medical standpoint, they correspond to cases of non-infectious pneumonia, for which the principal treatment is simply rest in bed. Since blast waves travel in straight lines, a person on the opposite side of a garden wall will be safe if the bomb does not explode too near. If no shelter is at hand, the best protection is to hug the knees against the chest, instead of lying flat. It takes a blast wave with a pressure of about 100 pounds to the square inch—from 10 to 100 times the amount needed to break a window—to threaten human injury.

Right after this wave, there follows a suction wave of longer duration, and of mild character in the open. If a bomb explodes in the confines of a built-up street, however, windows may be either blown in by the blast wave or blown out by the suction wave, accounting for the freak effects observed during heavy air raids.

Such is warfare today. Weapons for a future world conflict will soon be taking shape in research laboratories, if work on them has not already begun. It would be suicidal folly for us to fail to prepare for another war—and, perhaps, the same if we fail to prevent it.



THE SHIP WITH THE *Built-in Tail Wind*

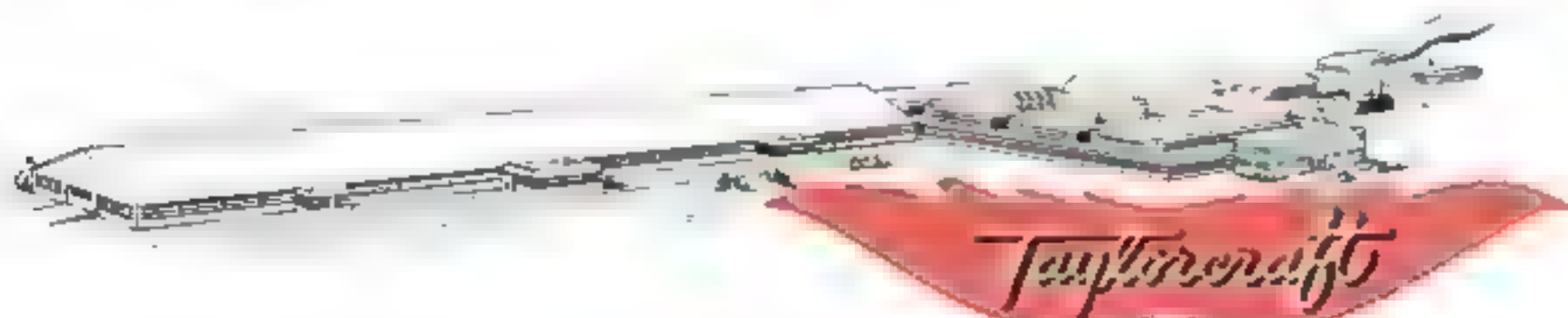
TAKE a 65 h.p. engine—put it in several different planes. What happens? One plane will outfly and outclimb the others, and use less fuel. It's no secret—any experienced light plane pilot will tell you, "Sure, Taylorcraft outperforms any ship in its class."

Just as Taylorcrafts flew in front before the war, and have repeatedly proved their ability for numerous war-time activities, so the new Taylorcraft will again lead the

field when America eagerly picks up peacetime flying.

As soon as current restrictions ease and Taylorcraft's war production responsibilities have been completely met, we want you to know what you can expect from Taylorcraft to make your flying safer and more satisfying than ever before.

Send us your name and address so you may be among the first to learn the news and details of Taylorcraft's newest developments.



World's Largest Builders of Side-by-Side Airplanes

TAYLORCRAFT AVIATION CORPORATION • ALLIANCE, OHIO

SEPTEMBER, 1944

Buy War Savings Bonds and Stamps regularly.

239

MILWAUKEE, WISCONSIN

EXTRA THE *Journal*

MILWAUKEE, WISCONSIN

**200 PRIZES GIVEN AWAY FREE IN DELTA
POST-WAR SHOP PLANNING CONTEST!**

ASSOCIATED AND PUBLISHED
BY THE DELTA CHAPTER

DELTA CHAPTER
123 45678

**You Have a
Chance to Win**

Here are the Rules
Be sure to read them!

[illegible]

2 Entries are to consist of a floor plan or sketch of the structure, a ground plan and bar chart showing the building process from the start to the end of the project. The work must be done in a clear and concise manner and must be in a form that is acceptable to the following date.

- A. Reasons for adopting system and equipment shown in floor plan
- B. List of power equipment now owned
- C. List of power equipment plans for purchase after the war the price you will pay and name of place where purchase should be made.
- D. List of hand tools and other accessories now owned
- E. General type of work to be done in the shop.

3 Entries will be judged on their suitability to the subject and work to be accomplished by a team of a random selection of people on the day of the competition. We cannot guarantee a prize for every entrant because of the large number of entries and the limited prizes available. The prizes will be given to the best entries.

4 All entries must be postmarked not later than midnight Tuesday October 31, 1961. They must be mailed to the Editor, The Delta Mfg Co., 6838 E. Young Ave., Milwaukee 1, Wis. Entries become the property of The Delta Mfg Co. to be used as they see fit, and none can be returned.

5 Decision of the judges will be final. In case of ties, duplicate prizes will be awarded.

6 Contestants are limited to one entry. If more than one entry is submitted by a contestant only the first one received will be considered.

7 Final editing will be done by William Bachrach, Research Coordinator of Engineering, Science and Management War Training.
E. R. Mann, Technical Editor, Popular Mechanics.
Harry Walton, Home and Workshop Editor, Popular Science.

★ 1st Prize ★

Your choice of \$1,000.00
in Delta equipment—(retail value)
Enough to have a complete Delta-
equipped homecraft shop you can
really be proud of!

★ 2nd Prize ★

Your choice of \$400.00
in Delta Equipment—*retail value*

★ 3rd Prize ★

Your choice of \$250.00
in Delta Equipment—(retail value)

★ 4th to 8th Prizes ★

Your choice of \$75.00
in Delta Equipment—(retail value)

★ 9th to 20th Prizes ★

\$10.00 worth of Delta Accessories and or Supplies!—(retail value)
(Merchandise certificates will be awarded to winners enabling them to prize when materials required for making Delta equipment are released by the government.)

★ 21st to 40th Prizes ★

Set of 27 Deltacraft Project Books
and Manuals! \$150 value!

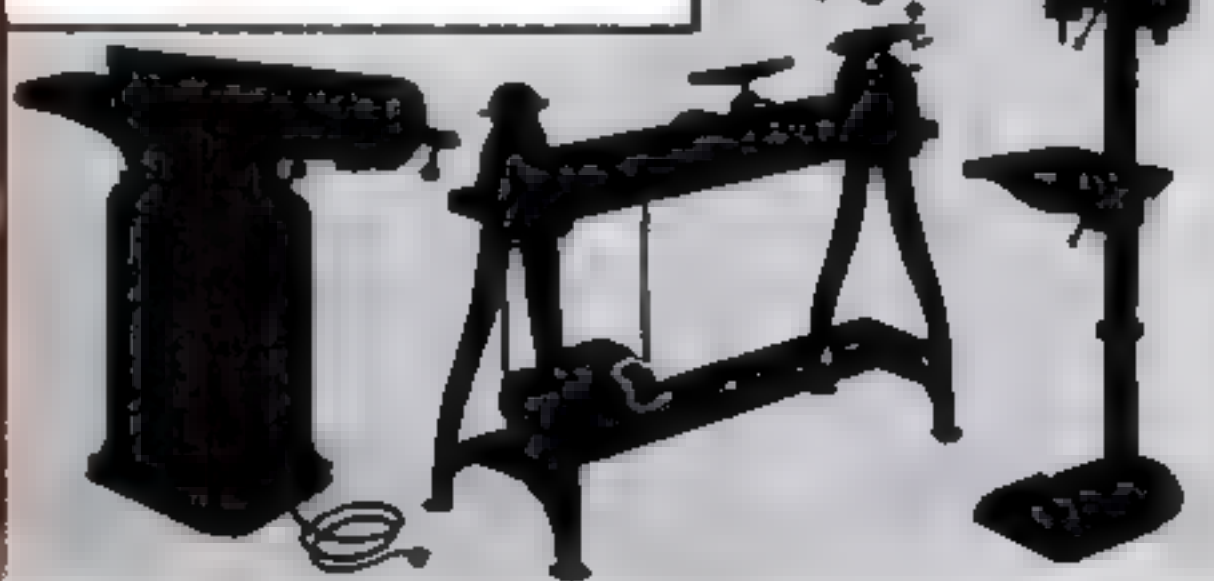
★ 41st to 60th Prizes ★

Set of 6 Delta Tool Manuals —
Value \$1.50*

★ 61st to 200th Prizes ★

**1 Year's Subscription to
The Deltagon!
Value \$06.**

**Here are
the Prizes!**



★ 1st Prize ★

\$1,000⁰⁰ in Delta Equipment

(Retail value)

for a Homecraft Shop!

Nothing to buy! No entry fee!
You don't have to be an expert to win!

Think of the thrill of winning \$1,000.00 worth of famous Delta equipment (post-war delivery)! Or one of the many other valuable prizes in this big contest!

And think of the fun, the healthful recreation you and your family can get from these tools, as you create things of beauty and utility out of wood and metal and fascinating new plastics!

Here's How to Get It!

All you have to do is to put down on paper your idea of a practical homecraft shop. Maybe it's that shop you've been dreaming about — or perhaps it's an improvement on the one you now have.

Whatever it is, simply send us a sketch of the floor plan (don't worry, we don't expect a mechanical engineer's finished drawing)—together with a statement covering the points given in the rules shown here.

Well Worth Trying For!

You haven't anything to lose by entering this contest — except the little time and trouble you take to get your entry ready. But you do have a lot to gain!

Delta homecraft power tools — made by the largest manufacturer of power tools for the homecraft shop — are truly fine tools. They're *accurate*—they're *dependable* — they're *safe*.

It's Up to You!

Now, whether *you* win these dandy Delta prizes—or whether someone else wins them — depends solely on *you*. Certainly you can't win, if you don't enter the contest. But you *do* have a chance, if you do send us your plan.

So read the rules now. Then, get a head-start on the others by going right ahead preparing your entry.

...and
 here's how
 to get them!

DELTA
 MILWAUKEE
 Power Tools

Some Helpful Tips that may make YOU one of the winners

To start you off on the right foot, we're going to tip you off here to some of the things the judges will look for. The judges, incidentally, are recognized authorities, not connected with The Delta Manufacturing Company. They will have the final say-so on the winners.

Check off the items as you include them in your plan. That way, you won't forget anything.

- ☐ Include a floor plan or layout of your proposed post-war homecraft shop, showing location and position of the power tools you would use. Indicate the size of area it would cover.
- ☐ List the power tools you think should be part of a complete homecraft shop.
- ☐ List the Delta power tools that you would like to get after the war. Give the name of the store where you would be likely to make such purchase.
- ☐ List the power tools — if any—that you now own.
- ☐ Are any of the following materials difficult to obtain in your locality during normal times? Wood? Paint? Finishes? Hardware? Plastics?
- ☐ What kind of tool racks, paint racks, storage bins for nails, screws, etc., would you recommend? How about lumber storage?
- ☐ Do you prefer to work in wood? Metal? Plastics? Or combination of all?

The above are simply suggestions. Include any other material that you think can help put you among the winners.

How much should a mother tell her daughter?



1 MY DAUGHTER BELLE is four months old now and curious about many things. Some have been easy to explain: for instance, that picture is The Boss.

2 BUT the other day I found Belle nosing around The Boss's favorite 22 rifle—the Remington Sportmaster. "Mom," she asked, "what's this for?" Well, how much should I tell her? Would her ears droop to learn what she was missing?



3 I DECIDED on frankness. "Belle," I said, "that's a Remington Sportmaster bolt action 22 repeater. The Boss and I would go out for long cross-country walks together, and he'd take along this Sportmaster and some Remington Hi-Speed 22's—'just for the fun of it,' he always said. And what fun it was!

4 "AND WHEN THE BOSS comes back, what swell times we'll all have! The Boss, Remington Sportmaster, you and I." "Gosh, Mom," Belle sighed happily, "that does sound doggy! And will you teach me what to do so that The Boss will like to have me along?"

► Remington has produced vast supplies of military arms and ammunition for our armed forces. And soon—we hope—we will once more be able to furnish sportsmen with Remington shotguns and rifles. Remington Express shells, Remington Hi-Speed 22's with Kleanbore priming, and Remington's big game cartridges with Core-Lokt bullets. *Remington Arms Company, Inc., Bridgeport 2, Conn.*

REMINGTON HI-SPEED 22's. When ammunition is again available, ask for Remington Hi-Speed 22's with Kleanbore priming.

Remington



Sportmaster, Hi-Speed, Express and Kleanbore are Reg. U.S. Pat. Off. Core-Lokt is a trade mark of Remington Arms Co., Inc.

If It's Remington
It's Right



How Hotter Steam Gives Our Navy Greater Speed

(Continued from page 80)

let her turbines spin at unusual speeds.

The turbine sets of our 35,000-tonners consist of a high-pressure and low-pressure turbine connected in series. The first is spun by fresh steam; the second uses the exhaust from the first, which cannot extract all the steam's energy. In the *North Carolina's* high-pressure turbine, high speed cuts the number of blades by more than three fourths, the length of the rotor by one quarter, and its diameter by nearly half, in comparison with an ordinary high-pressure turbine of the same power. Although special alloys are required to withstand the great temperature and pressure of the steam, the smaller turbine is more rugged and easier to build and balance.

During the last spurt of naval construction, the Navy preferred the turboelectric to the turbine-gear system for capital ships. Electric drive had several striking advantages. Vessels such as the *California* and *Tennessee* could be brought to rest from full speed in three minutes. By throwing a switch and reversing a current between generator and motor, these ships were able to use their electric motors as brakes. This also gave them unusual maneuverability. Moreover, one turbogenerator could easily be connected to supply all four shaft motors, with the other boiler and turbine units shut off at low speed, which made for economical cruising. Steam piping that can link any boiler to any turbine, and her improved gearing, however, give the *North Carolina*, in addition to her other advantages, near-turboelectric flexibility without the bulkiness of the generator-motor combination or others of its drawbacks, such as excessive loss of power between turbine and shaft.

The average efficiency of our more recent ships—the percentage of potential energy in their fuel oil translated into actual propelling horsepower—is about 28 percent, in contrast to the 20 to 22 percent of the last war's combatants. This gain results in part from the inherent efficiency of high temperature and pressure, and also from a super-heat-control boiler, which is so efficient that steam temperature can be changed faster than a mercury thermometer can record it.

High-temperature, high-pressure machinery has proved as easy to maintain as any other. It has, however, an implacable foe in oxygen. The slightest trace of oxygen in a steam system's feed water that has been heated to 850 degrees will result in its

(Continued on page 246)

America's Number One Manufacturer of Warm Air Heating Plants Announces

A NEW KIND OF FURNACE DESTINED TO SWEEP AMERICA!

COSTS LESS!...MORE EFFICIENT!...AMAZINGLY COMPACT!

ALREADY PROVED IN THOUSANDS OF HOMES!

FLOOR-LEVEL AIR DRAWN OFF HERE—QUICKLY WARMED—MEANS WARM FLOORS

AIR INTAKE CHAMBER SPREADS AIR INTO HEATING CHAMBER.

AIR IS WARMED AND CIRCULATED 3 TO 5 TIMES AN HOUR IN AN AVERAGE 5-ROOM HOUSE.

STREAMLINED BOTTOM MAKES AIR "FLY" 35% FASTER THROUGH THE FURNACE!

80% OPEN REGISTER SPEEDS WARMTH TO EVERY CORNER OF YOUR HOME.

COMPLETELY AUTOMATIC! NO DIRT, ASHES, SHOVELING OR WORK

NEEDS NO BASEMENT—NO DUCTS AIR FLOW PRINCIPLE GIVES BETTER COMFORT.

GET THE WHOLE STORY OF THIS "HEAT OF TOMORROW" FROM THIS FREE BOOK!

FREE!

The "INSIDE STORY" about this and other "magic" heat plants.

IT'S CALLED A "FLOOR FURNACE"—BECAUSE IT IS SET IN THE FLOOR!

Here is some of the practical Coleman heat-magic you can have after the war. New "warm-floor" comfort—automatic effortless ease—surprisingly low fuel cost. One of a group of advanced heating plants, perfected by Coleman engineering genius. Gas, oil, butane models will be available.

A book of solid facts about the different type of heating that will be available when production is resumed. Mail coupon for your copy, to Coleman Lamp and Stove Co., Dept. SM-417, Wichita 1, Kansas.



**THE "HOT" NAME
IN HOME HEATING**

THE COLEMAN LAMP AND STOVE COMPANY
WICHITA 1 • CHICAGO 11 • PHILADELPHIA 8 • LOS ANGELES 54

THE COLEMAN LAMP & STOVE CO.,
Dept. SM-417, Wichita 1, Kansas.

Without obligation, send me your FREE Illustrated book,
"The Inside Story of Tomorrow's Home Heating."

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Town _____ State _____



Satisfying GOOD TASTE

Never sharp...Never bitter...Always mellow

Blatz Brewing Co., Milwaukee, Wis.

In our 93rd year



**NEXT TIME USE
WELDWOOD
GLUE!**



Weldwood Glue Has Everything:

1. Tremendous strength. 2. Waterproof, bacteria- and rot-proof. 3. Quick and easy to use. No heating. No waiting. Mixed just by adding water to powder. 4. Economical. 5. Applied cold, quick-setting. 6. Stain-free. Supply limited due to Uncle Sam's war needs.



Scientific shear tests prove that Weldwood Glue "makes the glue line the Safety line." It is actually stronger than the wood it joins!

Wherever wood meets wood, this modern plastic resin adhesive does a quick and permanent "welding" job. It's one of the handiest "tools" a home hobbyist or repairman ever had.

Your hardware store or lumber dealer has packages of Weldwood Glue in 10c, 25c, 50c and 85c (1 lb.) sizes and 5 lb. cans. Get a can today or send 25c and your dealer's name for a trial 3½ oz. sample.

UNITED STATES PLYWOOD CORPORATION
Weldwood Glue Dept 103 59W 44th St, N.Y. 18, N.Y.
"Makes the glue line the SAFETY line"

WELDWOOD

PLASTIC RESIN
WATERPROOF GLUE



The Postwar Plans of Mr. G. I. Joe

Most of his plans are pretty simple, but more vivid and convincing than the best drawn blueprint of a postwar miracle. Some of them look a lot like the picture above. The same old water and rocks, reeds and pines. Plenty of good fishing and savory slabs of just-caught bass sizzling and browning in the pan. And finally the welcome old chow call . . . "Come and get it".

V-mail from a host of "planners" indicate that a sparkling new Evinrude will be an important part of the picture. On battle fronts around the world the boys have watched Evinrudes deliver the kind of performance they respect . . . and want more of when they get back. Our plans are to provide it for them . . . to the very top of their expectations!

EVINRUDE MOTORS, Milwaukee 9, Wisconsin

★

*Every Dollar You Invest Helps Speed
Victory . . . Buy More War Bonds*

EVINRUDE



OUTBOARD MOTORS

**"A Thing of Beauty
AND A
(SMOKING) Joy Forever!"**

Just as fine collection American fine
line, as fine pipe craftsmanship de-
serves fine briar!

These fine briars are imported from
from the Mediterranean region. So that's
the material we give the master pipe-
makers of LHS to work with—that and
solid rubber bags, sterling silver bands,
and personal pipe-making "know-how"

LHS

**STERNCREST
STERLING**

5

Smooth and Antique-Fin-
ish, many handsome
models, each one num-
bered, registered and
guaranteed by LHS.

No. 12
Self Model

LHS

14K

We select briar of rare grain and beauty,
circle it with solid gold, and offer the
Sterncrest 14K to the ultra-discrimi-
nating who want to own, and **\$7.50**
give, the ultimate in pipes.

All good pipe dealers carry LHS famous pipes

L. & H. STERN, INC., Stern Bldg., Brooklyn 1, N.Y.

Makers of **LHS** Ultra-Fine \$18 and Pure Pipes \$3.50, \$4.50

YOU WILL UNDERSTAND—Thousands of LHS pipes
are now going to the armed services. If you can't al-
ways locate the LHS model you want, remember, any
LHS is "Perfection in a Pipe."

Put this in your
pipe and smoke it.

BUY WAR BONDS

How Hotter Steam Gives Our Navy Greater Speed

(Continued from page 242)

speedy destruction by rust. Consequently,
the Navy has evolved one of the most effi-
cient de-aerating systems now in use.

Our first high-pressure, high-temperature
turbines were installed in the *Mahan* de-
stroyers, completed in 1936-7. The *Mahans*
had double-reduction gears, de-aerated feed
water, and 400-pound 700-degree steam.
But the Navy had its troubles with the *Ma-
hans*: the engine room was so cramped
that the ship's side plating had to be cut
open to make engine repairs; deck plates
buckled; and an attempt to heat the steam
to 850 degrees had to be abandoned.

Even while the *Mahans* were still build-
ing, the Navy went to 450 pounds in the
Porter class of destroyer leaders, and in
June, 1935, laid down a leader of another
type, the *Somers*, which operated on the
steam condition that has since become
standard: 600 pounds and 850 degrees. She
also had the first boiler using the new
superheat control.

The *Somers* proved herself instantly, de-
ciding the Navy to change the power plants
of the *North Carolina* and *Washington*,
which had already been started. On 600
pounds, 700 degrees, the *Somers'* fuel con-
sumption was 22 percent less than that of
her 300-pound, 600-degree rivals (whose
boilers, turbines, and gears took up 22 per-
cent more space and weighed 41 percent
more) and nine percent less than that of her
450-pound, 700-degree sisters. At 800
pounds, 850 degrees, the *Somers* cut her
fuel requirements by another ten percent.
Later destroyers, with special cruising tur-
bines that stretch the oil supply, bettered
this gain by another two or three percent.
They developed 10,000 horsepower more at
800 pounds, 850 degrees than at 600 pounds,
700 degrees—enough extra thrust to main-
tain battle speed even with several months'
barnacles fouling their bottoms.

In 1939, Britain launched the first of her
multipurpose light cruisers, the *Dido*, with
steam conditions of 400 pounds and 700 de-
grees. In the same year we re-engined the
Dahlgren, one of the World War I four-
stackers, to operate on 1,300 pounds' pres-
sure and a temperature of 925 degrees. The
Dahlgren is another 10 percent more eco-
nomical. For the moment, the *Dahlgren's*
machinery is not being duplicated, owing to
the scarcity of high-test alloys, but she is a
guarantee of the maintenance of American
leadership in naval power plants in the
years to come.

FIRST ON MY *Want List* IS A NEW HARLEY-DAVIDSON



"Your motorcycles are doing a swell job . . . Believe me they really catch hell here in New Guinea. But they can take it. Better performance, speed, and easy to ride. It's the A-1 motorcycle for me, and I salute you—the makers of the one and only Harley-Davidson.

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Available now in limited quantities at many dealers smartly fashioned Elasti-Glass braces with yielding 100% full stretching comfort in wide range of sport tones. Clip or button ends - \$1. Also Elasti-Glass Stratton Belts in Tan, Grey or Brown with handsome Giant Grip buckle 100% stretching comfort \$1.

*Elasti-Glass is an ORGANIC GLASS and is made of almost 100% plastic and contains no steel or rubber. Trade Mark Registered U.S. Pat. 1,777,000. Made in U.S.A. Covered by Trade Mark Reg. U.S. Pat. No. 2,222,212.

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Dealer's Note: Limited stocks on hand at our New York, Chicago and Los Angeles Offices.



How to enjoy starched collar neatness & soft collar comfort

The answer is SPIFFY—the invisible collar stay with the self-adjusting springs. Smooths away wrinkles and collar curl—holds down the points—keeps a fellow looking neat, smart and trim the whole day long.



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It's a "Must" with the boys in khaki... they're easy to mail. Why not send two or three to your man in the service?

Every man should have three or four—25c and more at men's stores everywhere.

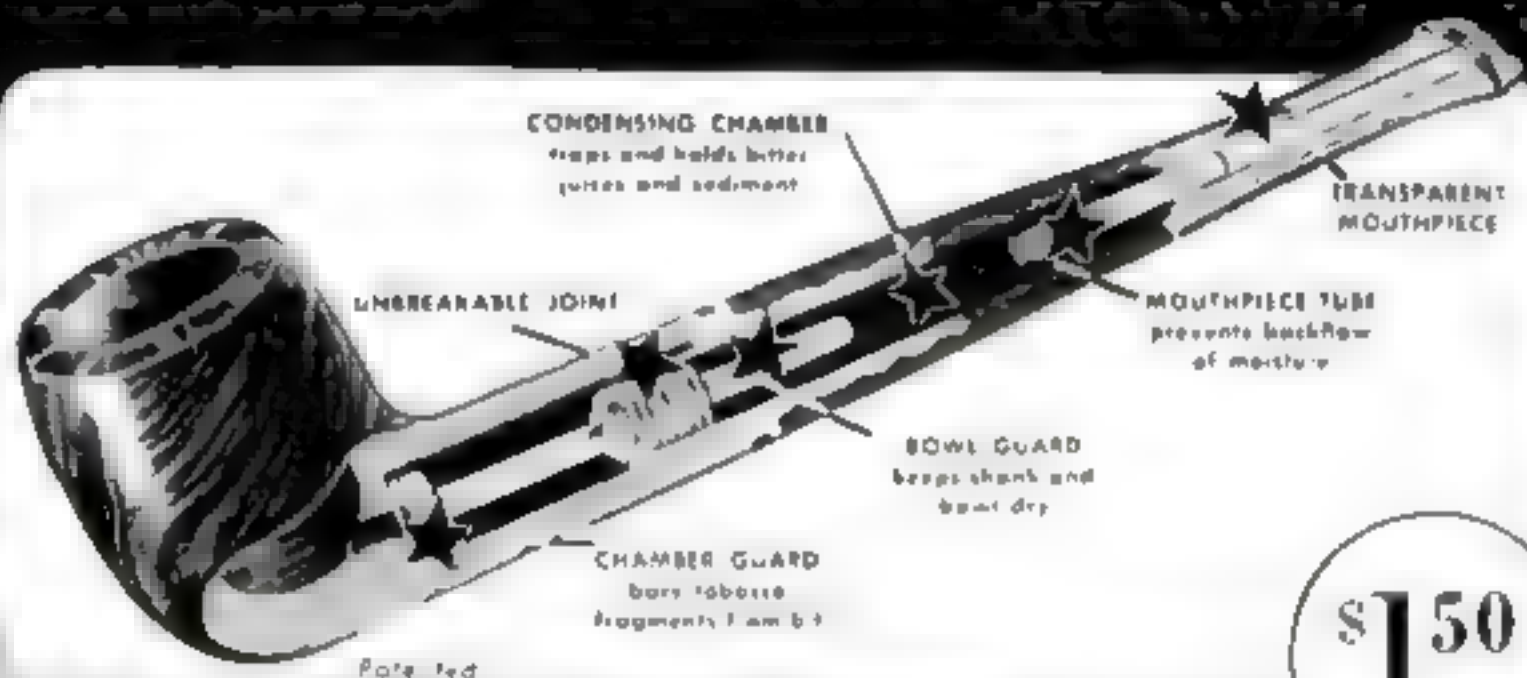
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CREST SPECIALTY CO., 663 W. Washington St., Chicago 6, Ill.

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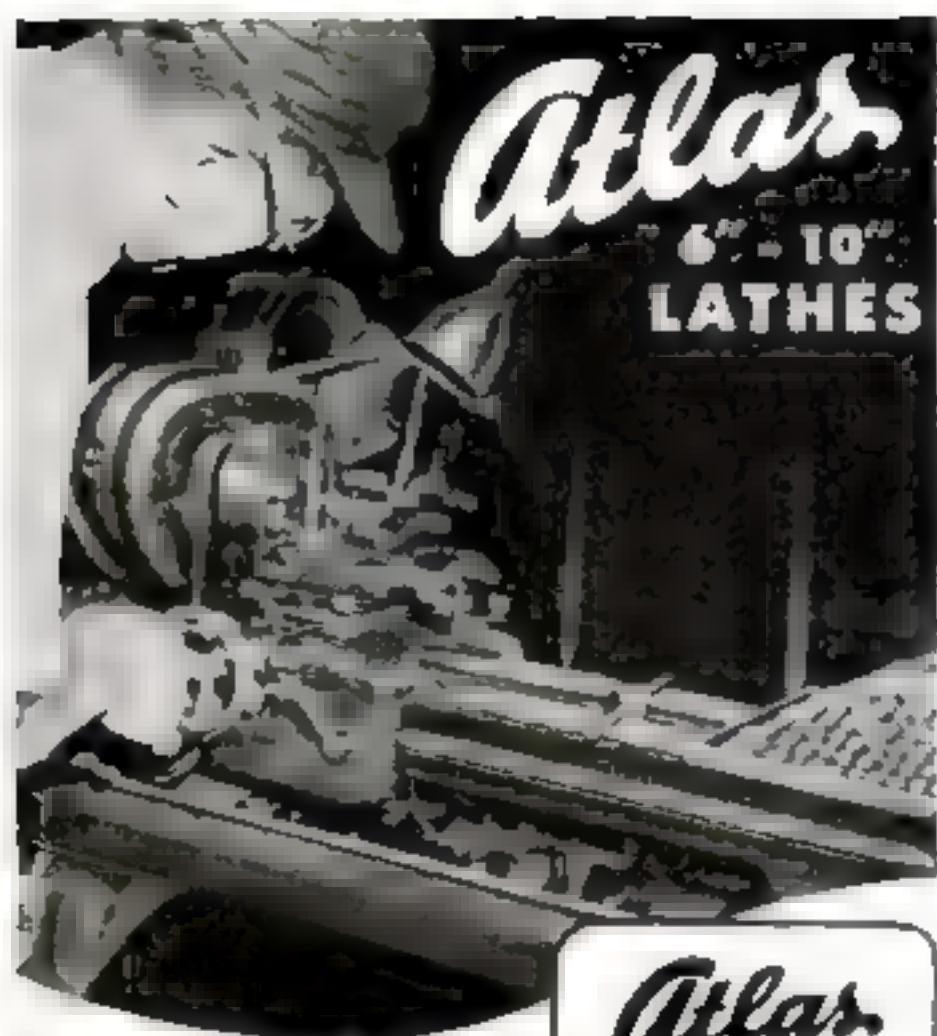


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Precision-proven by the rigors of vital war production, Atlas lathes are the ideal all-around machine tools for commercial or private shops. Only MRO or higher priority orders can be entered now. But when war needs are filled, be sure to see the versatile, low-cost Atlas tools in action before you buy! Send for latest catalogs.

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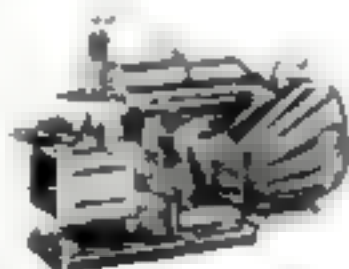
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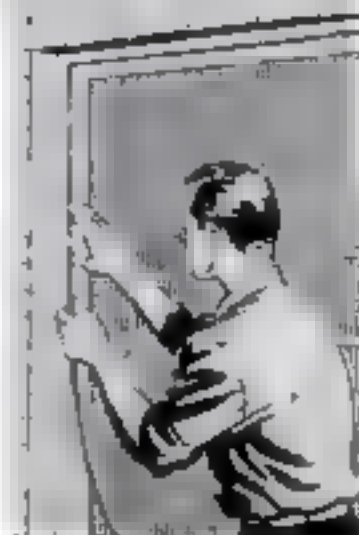
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WHY USE A NUT?

A nut draws things together and holds them tight. It permits taking apart and refastening.

If a nut loosens by itself, it fails in its job. A good nut must always hold.

That is the unusual virtue of the Elastic Stop Nut. Where an ordinary nut lets go, this one grips fast. It locks anywhere on the bolt. It can't wiggle or turn of its own accord—even under severe vibration.

But you can take it off and put it back on time and time again. It still locks. And it never mars the bolt.

The reason is the elastic collar in the top. When the nut is turned on, this collar squeezes between the bolt threads and hugs tight.

This provides security. That is why Elastic Stop Nuts are used by billions in America's airplanes. There are more of these nuts used than all other lock nuts combined.

After a while you'll see these nuts with the Esna red collar on the things you buy. And count on it—whether it's a new car, refrigerator, radio or what not, it will be stronger, safer, quieter and longer lasting because of Elastic Stop Nuts.



The Railway Express Agency uses a great many Elastic Stop Nuts on its fleet of 15,000 trucks. It uses them on many of the chassis and truck bodies as illustrated above, because once drawn up tight, they hold fast. No periodic taking up — no loose, squeaky or rattling trucks on the road, even in the face of day-in, day-out going and stopping on all kinds of roads.

LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.

THE COLLAR IS ELASTIC, THE NUT CAN BE USED TIME AND TIME AGAIN.

MADE IN ALL SIZES AND TYPES—WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.

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TRADE MARK OF
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ELASTIC STOP NUTS
Lock fast to make things last
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SAVE THAT SAW!



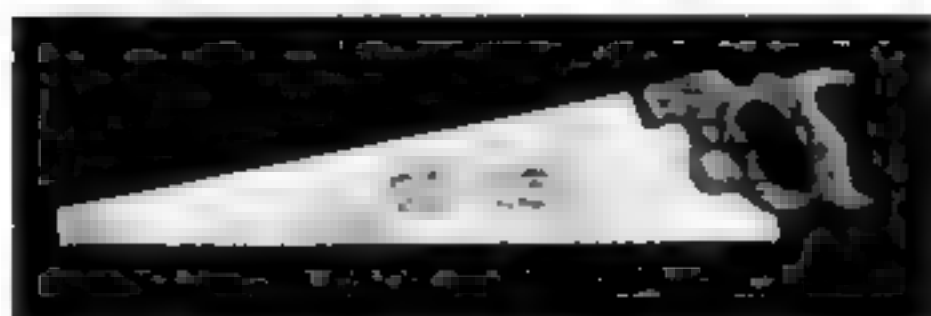
A saw that's dull makes muscles ache!
Get it fixed for goodness sake!



Take it to your hardware store—
Saving tools helps win the war!



Where you see this window sign . . .
You'll get work that's extra fine!



Later on, you can insist on
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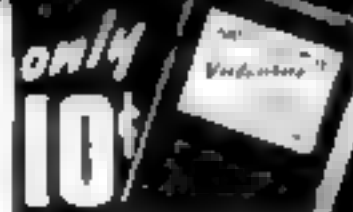


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Use Care—Don't Break It

AND INSURE CARE IN HANDLING WITH

**Dennison
CAUTION LABELS**

At Stationery Departments Everywhere



WAR BOND

A GRAND TOTAL OF

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IN PRIZES

Midwest Radio Corporation—since 1920, famous for fine radios, and their factory-to-you selling plan with savings up to 50%—looks to the post-war future. To build the kind of radio you want, they ask you now to submit a letter on the subject: "What I Want In My Post-War Radio." For the 11 best letters, Midwest will give \$1,000.00 in War Bonds. Letters must not exceed 200 words and you may send as many entries as you wish. Letters will be judged on the practical value of the ideas contained therein and the decision of the judges will be final. In case of ties, duplicate prizes will be awarded. All entries must be postmarked not later than midnight Dec. 31, 1944. Contest open to all except employees of Midwest Radio Corporation, their advertising agency, and members of their families. Winners will be notified on Jan. 31, 1945. Prizes will be awarded as follows:

First Prize . . . \$500 in War Bonds

Second Prize . . \$200 in War Bonds

Third Prize . . . \$100 in War Bonds

and eight prizes of a \$25 War Bond each.

Send your entry to Contest Editor at
MIDWEST RADIO CORP., Dept. 59 H, Cincinnati 2, O.



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Adjustable
HOLE CUTTER

ONLY

\$29.5

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Ideal for electric drills and light drill presses.



Cut deep holes in wood or compressed material.



No trick to set and re-set adjustable cutting blade.

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Street.....
City..... State.....
Calif. Purchasers add 2 1/2% Sales Tax

The Tug That Went to War

(Continued from page 63)

Bay while a U. S. cruiser fired across her stern at Jap positions in the hills; and at Kiska, Captain Kroll actually saw the startled Japs who were soon driven out.

At Attu, the *Moran* also landed runway matting from a freighter two miles offshore. Captain Kroll did this by lashing his old girl to the side of 200-ton, flat-bottomed barges, then plunging bow-on into the beach under full power. Roaring tractors would then snake each barge to safety, while the tug backed off and went back for another load.

One overloaded barge capsized, smashing the *Moran's* railing, top decking, and galley door. "I started to back up like a son of a gun," Captain Kroll grins. "I knew she would sink, and I kept men standing by the line with axes." But the tug escaped, and that was the only load of hardware she lost while beaching a dozen or more barges a day for a week on the foggy Attu shore.

Another neat trick was the landing of food for more than 3,000 American soldiers who had gotten on one Aleutian isle without being discovered by the Japs. Without more supplies, those men would die; but if discovered too soon, they would be slaughtered. The Japs' detection equipment would almost certainly pick up the steel hull of any supply ship that ventured near that isle. How, then, could more supplies be delivered to those men without disclosing their hideout?

The Captain studied the charts and weather reports. Then he loaded a string of wooden boats with the necessary supplies and towed them to a point far from the island. Choosing just the right time and place, he cut those boats loose, and the current swept them toward the isle.

Before his old girl had to return to the states to be overhauled, she had proved many times that a tugboat—like the mouse that gnawed a rope to free a roaring lion from a trap—can sometimes be of more service than the greatest ship that ever sailed the sea. Her captain had been honored by both his own and the British Governments, and his superiors felt that he was entitled to time out, but he and the *Moran* quickly put to sea again.

"They asked me didn't I want to quit," said Skipper Kroll, during his few days with his wife and daughter in the little home he had built in a New York suburb in 1918. "I thought it over, but," the captain coughed, "I couldn't let anybody else take that old girl out. Not while the war is on. We got plenty more work to do, me and that old devil."—VOLTA TORREY.

"A guy with a Marlin Rifle
just scared the spots off me!"



WHEN YOU GO FISHIN'-TAKE A FRIEND!

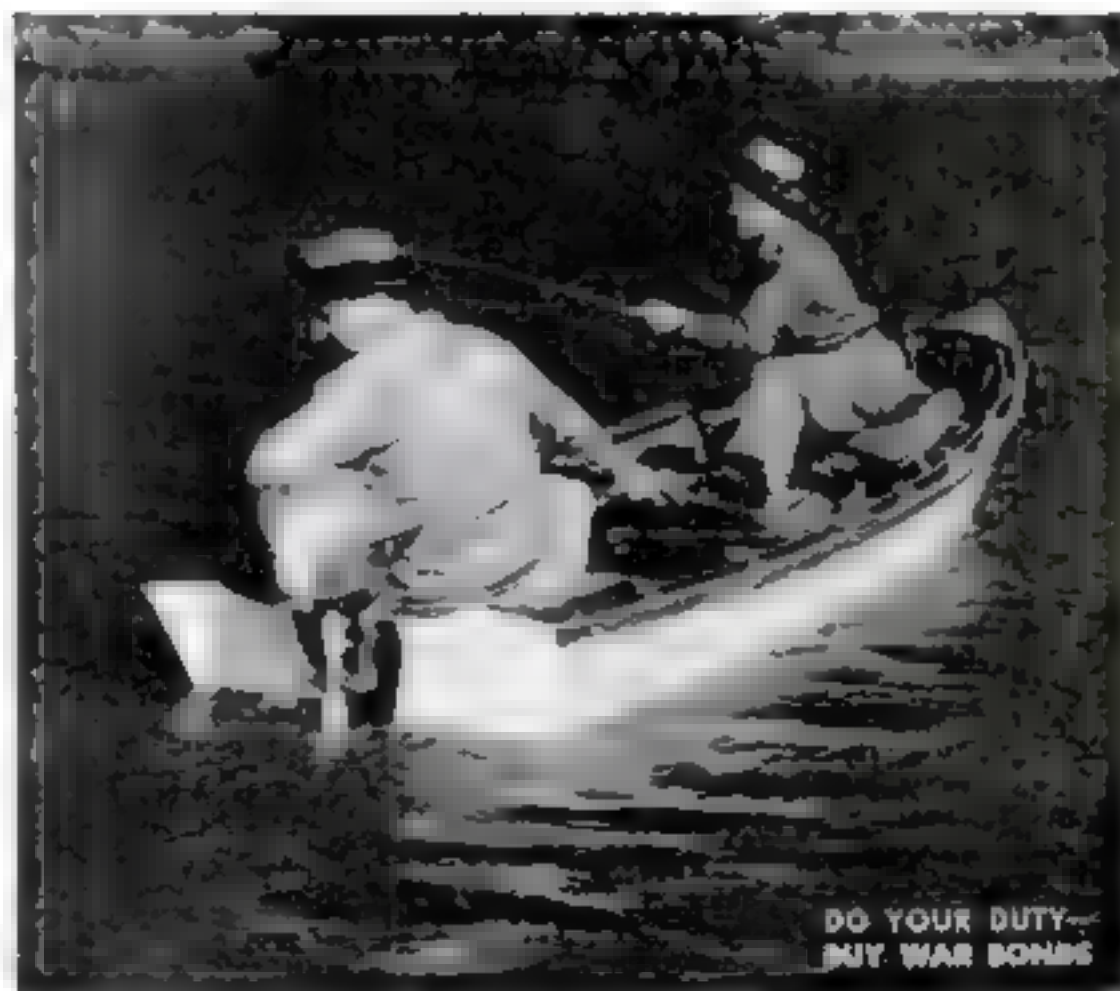
THERE are lots of folks (who've never fished) who need the solace and relaxation of a fisherman's day on the water. Give *them* a taste of this healthful, healing sport. Share your fun... When you go fishin', take a friend!

It goes without saying, of course, that you'll have more fishin' time—and more fun all around—if the third party on your trip is a Sea-Horse. The Sea-Horse is a born fishin' friend. JOHNSON MOTORS, 500 Pershing Road, Waukegan, Illinois.

DEALERSHIPS: All of today's Sea-Horses are for the armed services and essential needs. But if you are interested in selling and servicing outboard motors after the war write us now no matter what your location may be.



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No Substitute For
Experience



DO YOUR DUTY—
BUY WAR BONDS

JOHNSON SEA-HORSES for DEPENDABILITY

WEAREVER

Zenith



\$1.95

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Fountain Pen
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TELESCOPE PRECISION realizes new pen perfection

The Wearever Zenith writes like a charm, effortlessly. From blueprint stage to finished pen, precision marks every step in its making . . . yes, precision comparable to that lavished on a fine telescope Telescope Precision! With its 14-carat gold point, its exclusive "C-Flow" feed, its rich color selections, Wearever Zenith sets new fountain pen standards. Made by David Kahn, Inc.

Wearever Zenith Pen and Pencil Set in the gift box **\$2.75**



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Here's already-colored wax in **HARD-TO-GET COLORS**



• If you've got a nick or mar to cover in a table top . . . or want to bring back the rich, mellow finish on an old piece of cherry, maple, or pine furniture . . . or finish a repaired section to match older wood . . . here's an assortment of colored waxes all ready to use.

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SHINOLA



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RUST-PROOF ANYTHING IN 2 MINUTES!

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Catalog with 2000 illustrations of laboratory apparatus sent for 75 cents. Catalog listing in the chemicals, drugs, minerals, etc., and from which to order for 25 cents.
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Good for killing worms, attacking yew, ring, apartment stores, etc.
a complete illustration, 1944. Packed for worms for people, the dog.



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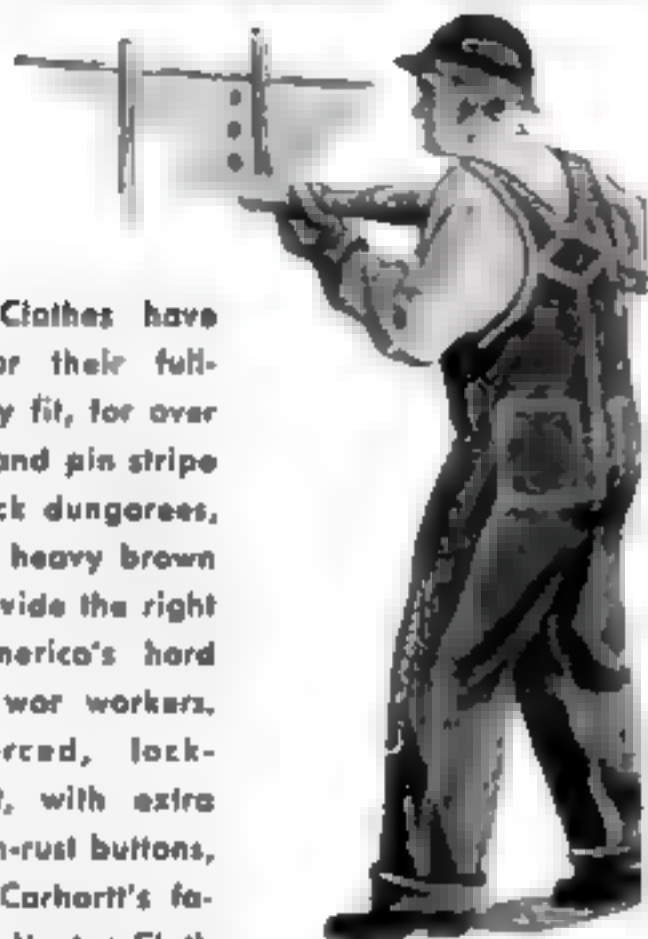
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 On sale at your local dealers

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UNION MADE WORK CLOTHES

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 KIT for the 1/2 mile yard. No 1 **\$195**

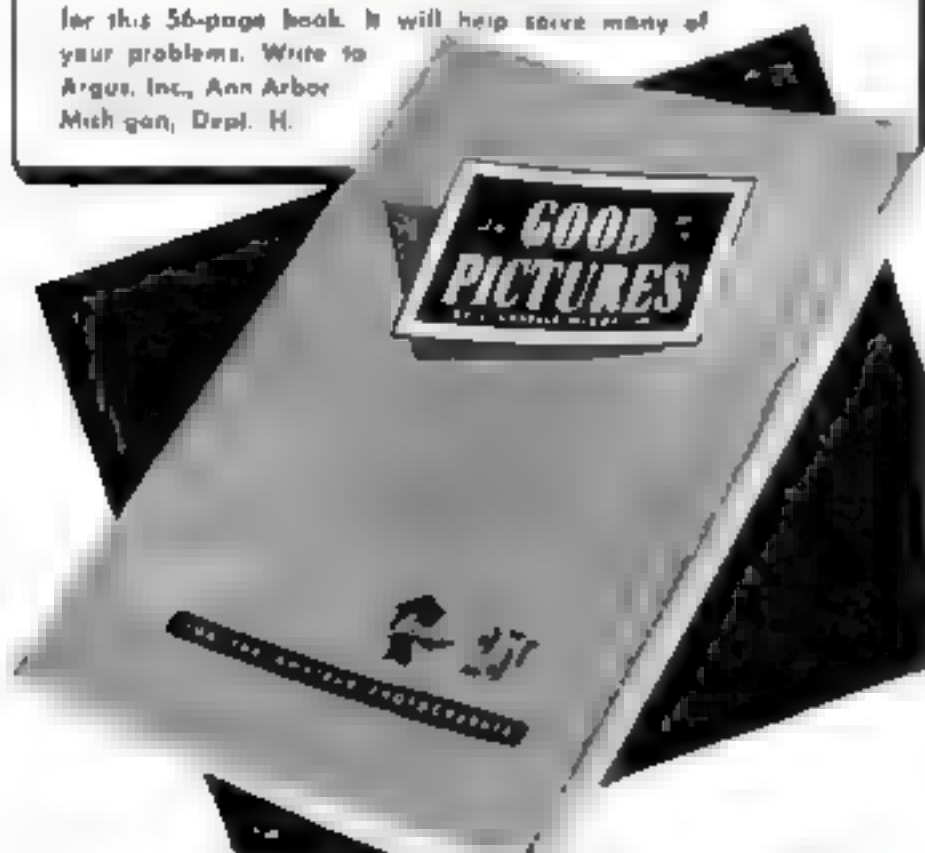
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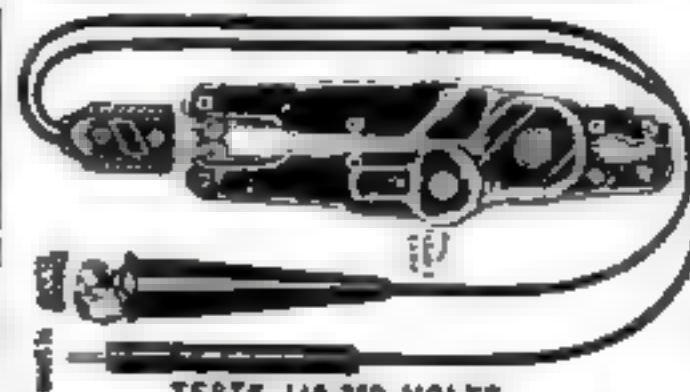
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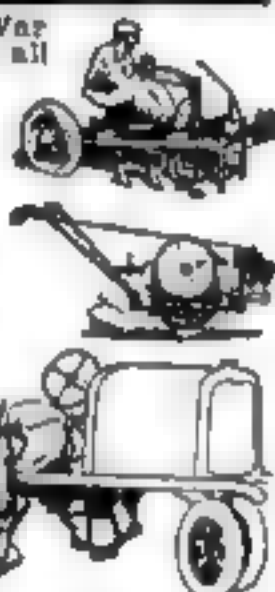
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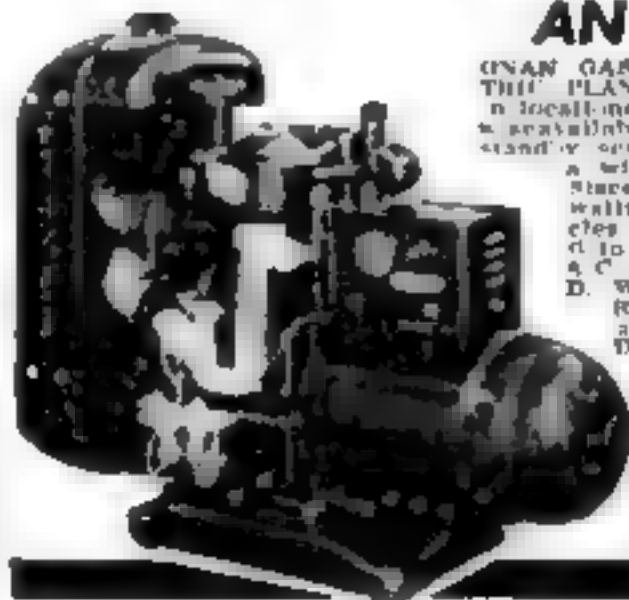
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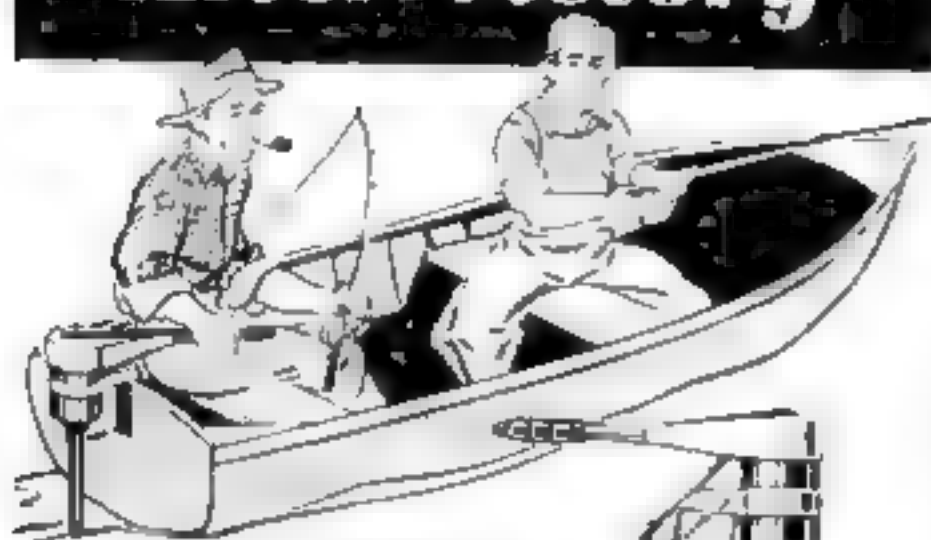
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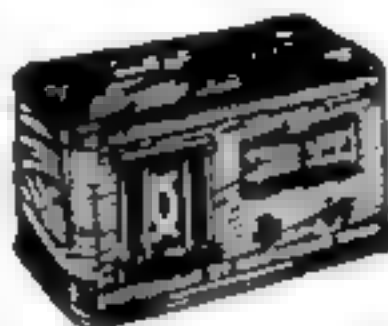
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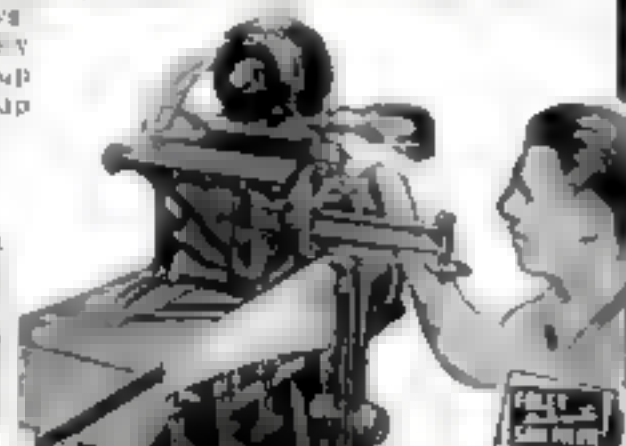
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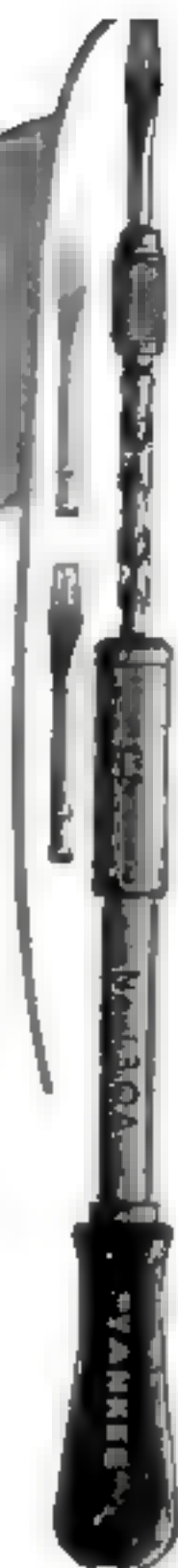
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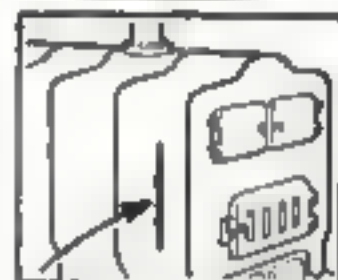
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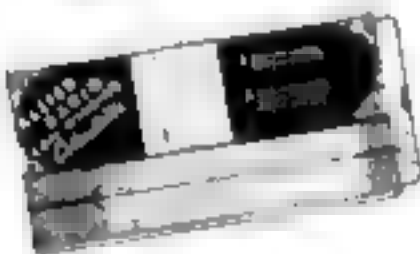
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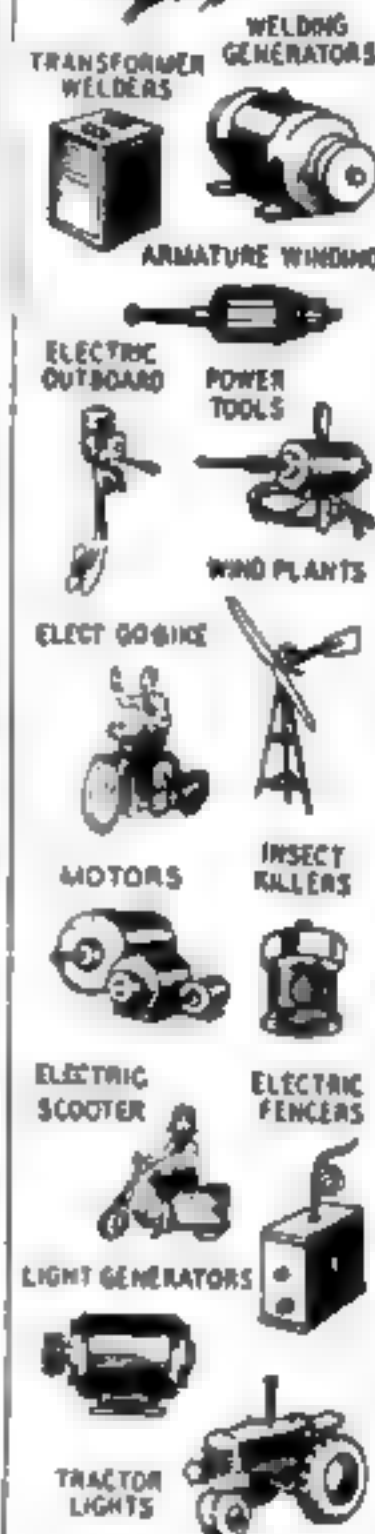
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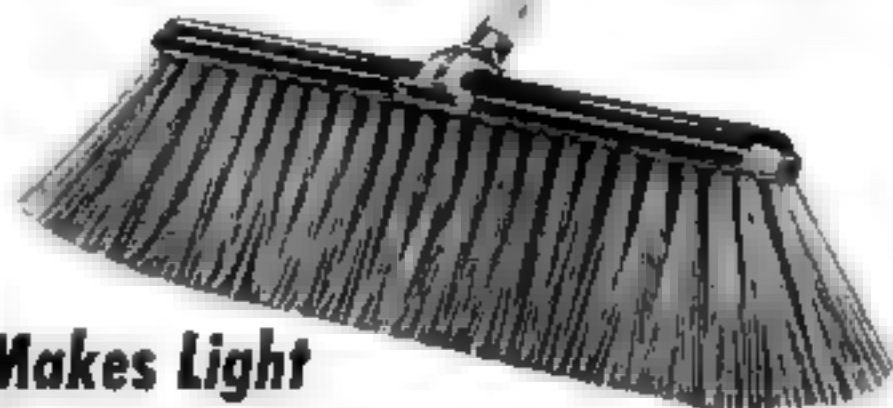
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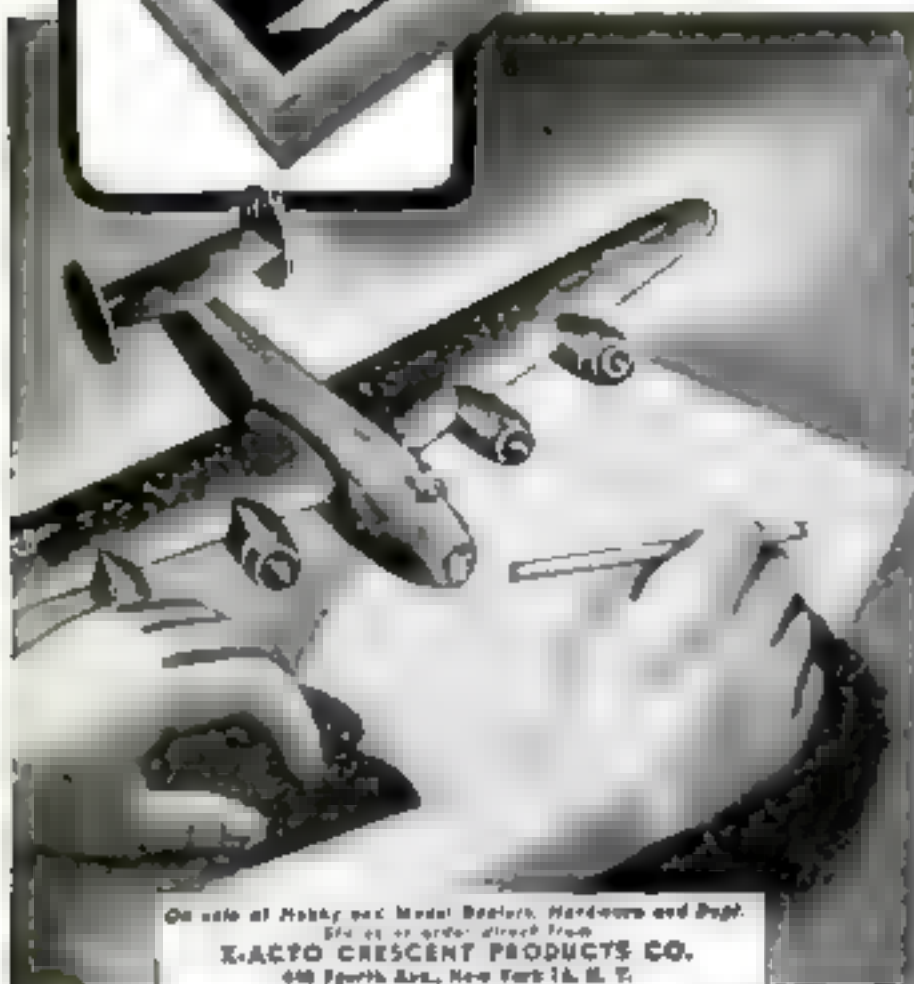
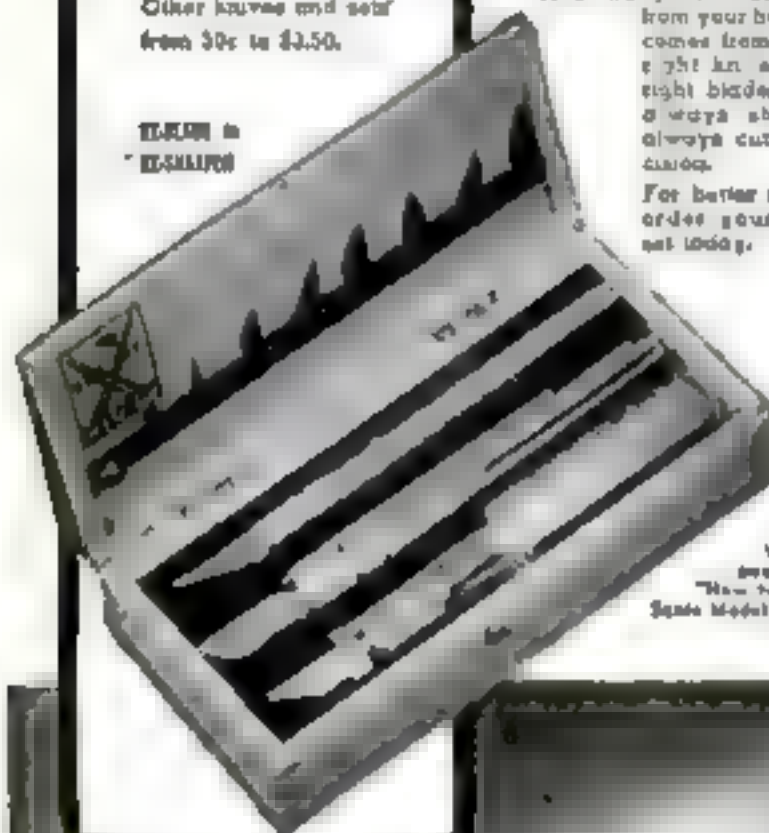
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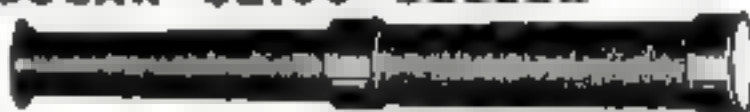
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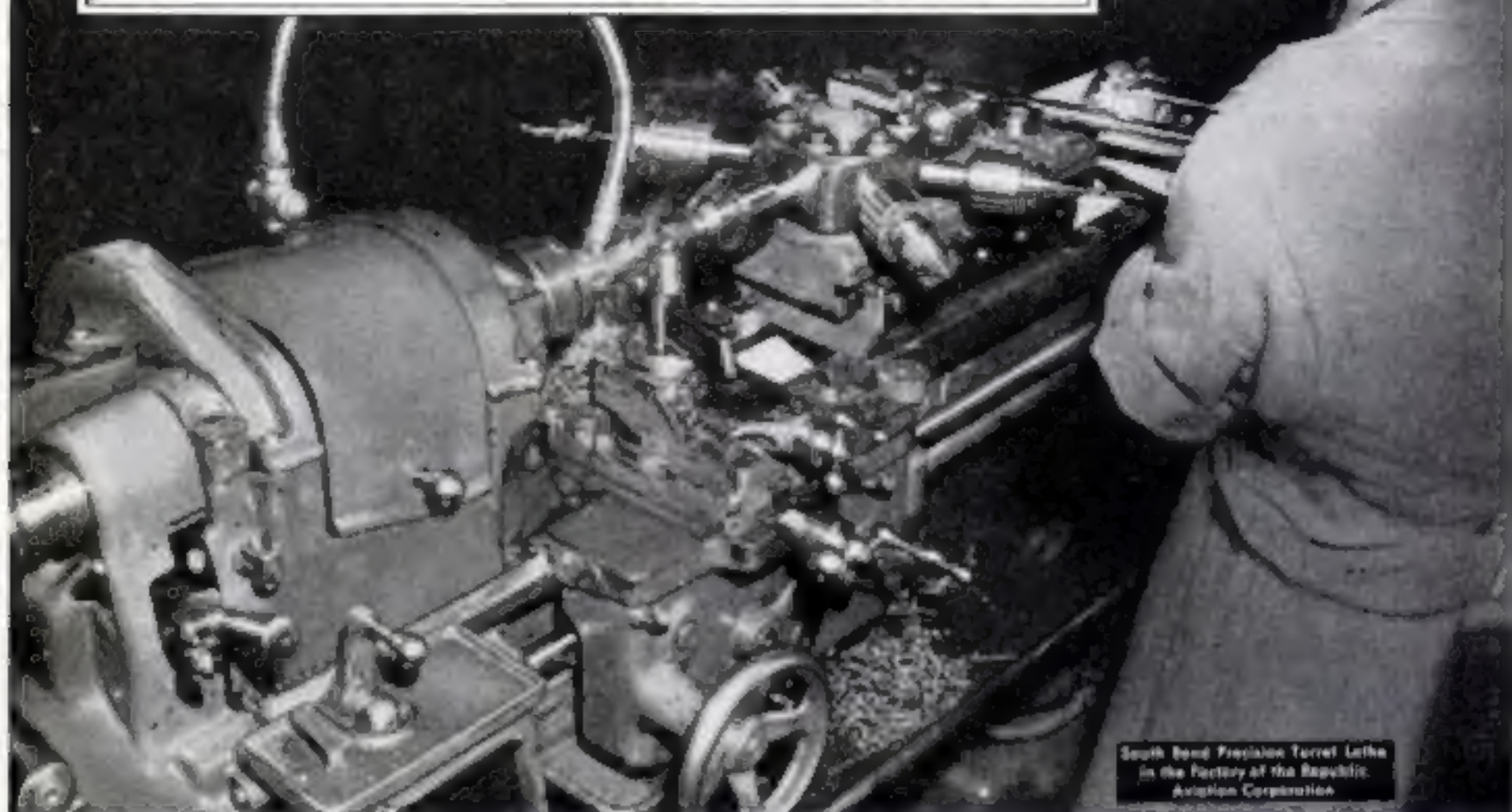
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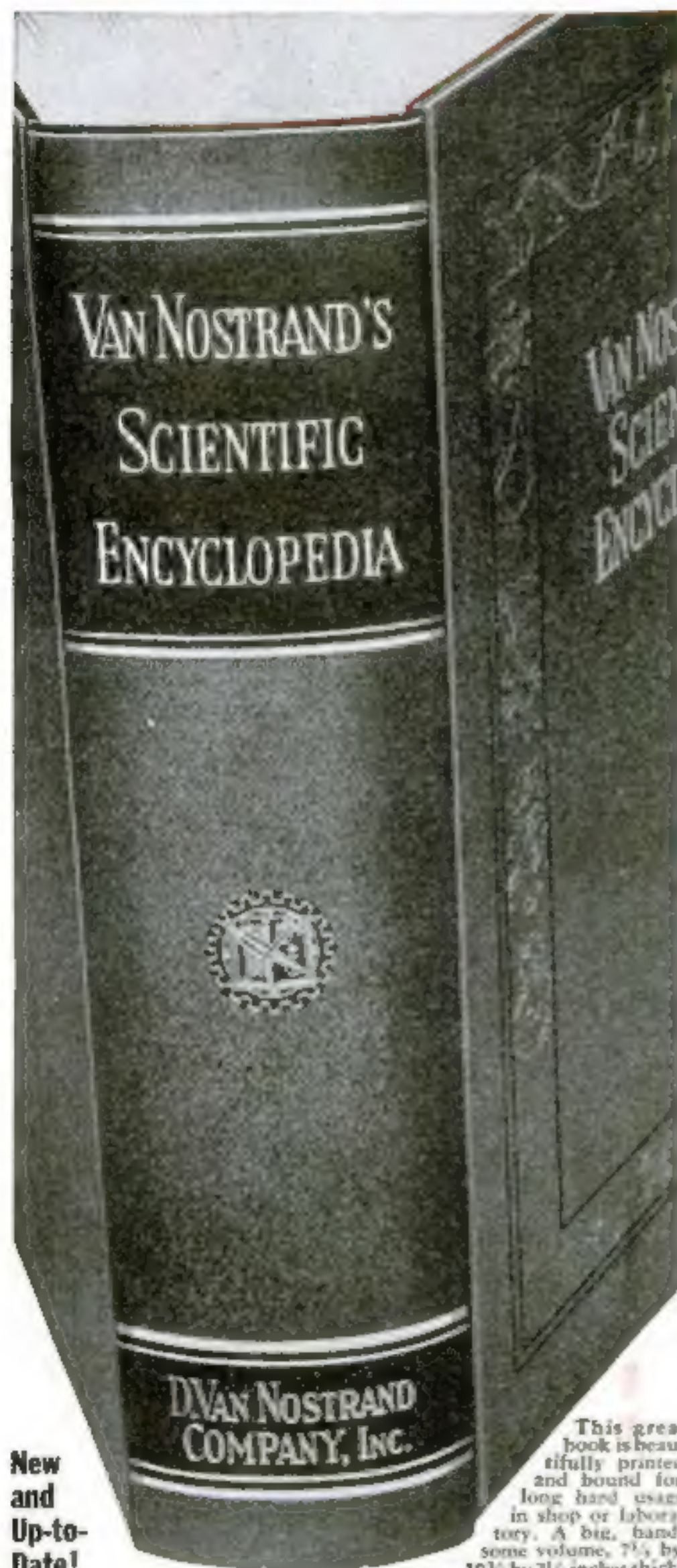


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